the OIL AND GAS JOURNAL
PUBLISHED WEEKLY MARCH 13, 1961

ANNUAL
NATURAL–GAS,

Natural-Gas Pipeline Report

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JOINT STUDY SHOWS

Drilling costs still rising

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Gas hearing ends on harmony note

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Coming: Record gasoline surplus

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Operators eye savings in slant-hole drilling

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Deeper drilling needed to launch Florida as real oil state

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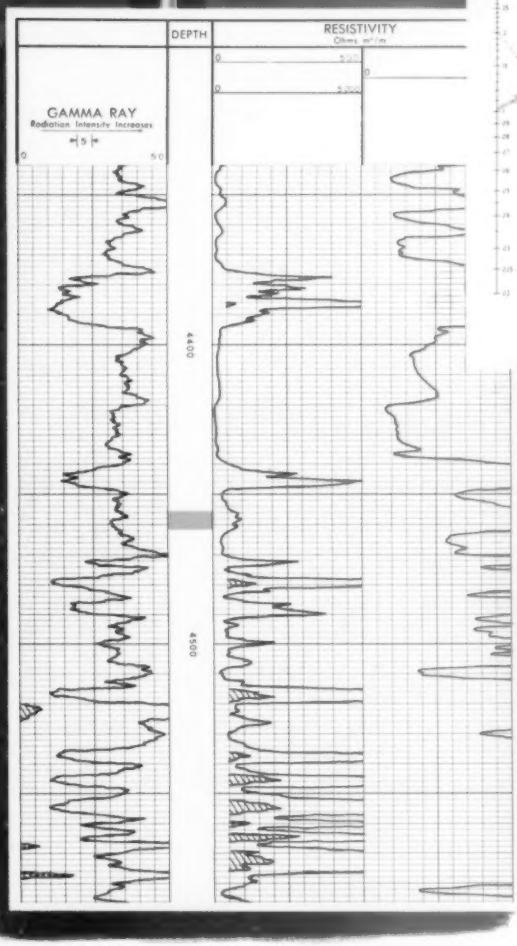

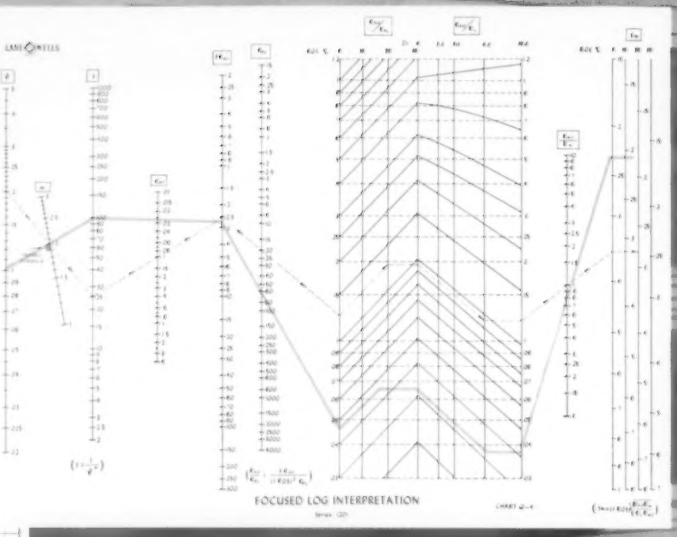

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SPECIAL NATURAL-GAS, GAS-PIPELINE SECTION

Report on Alberta-California Gas Pipeline System 109

By Paul Reed

Here is the full story of this significant new development—design of the line and its stations, underground storage, reserves, markets, and costs. Field plants facilitated construction considerably. Arrangements for acquiring gas and transmitting it have been made on an unusual cost-of-service basis. Ultimate delivery to California will be 800 M.M.c.f.d.

California Becoming Nation's No. 1 Gas Market 122

By John P. O'Donnell

Pipeline projects building and proposed will double present supply. They're a $2.5 billion investment in 13,700 miles of line to deliver 3.9 billion cubic feet per day. One major line has been completed only recently, a second is building, a third is approved, and a fourth and fifth are proposed.

Midwestern Construction Methods Matched with Terrain 133

By H. C. Bozeman

Midwestern Gas Transmission's new 495-mile, 24-in. line from the Minnesota-Canada border to Marshfield, Wis., crosses three distinct, different terrains. It matches these conditions by combinations of double jointing, external wrapping, and field techniques.

Boosting Pipeline Flow Efficiency 141

By Adrian W. McAnneny and Lester C. Sullivan

Sandblasting gives a cleaner and more efficient pipe than either pigging or in-place coating. Efficiencies approach within 3% of the theoretical maximum.

Grinding for Stringer-Bead Preparation Means Better Welding 149

By A. G. Barkow

Gross cost of welding is reduced, including cost of weld repair. It's found that high-heat cutting is not required in running the hot pass, so it can be run faster. The root bead as well as all other beads must be cleared before the next bead is applied.

New Controls Up Compressor Engine Efficiency 161

By J. M. Ranck

Automatic device regulates speed and mixture. Improved fuel economy makes for early payout.

Natural Gas is Texas' Industrial Lifeblood 167

By Dr. Frank J. Gardner

It has replaced crude oil as the fair-haired child of Texas' army of oil operators. And they're spending plenty of money to find it.

TECHNOLOGY—OPERATION

Save Big Money When Drilling Crooked-Hole Formations 176

By Ed McGhee

New Tool Bevels Cement-Lined Pipe 180

By W. B. Bleakley

Plastic-Coated Valves Stand The Gaff 181

High Efficiency Marks New Benzene Unit 182

By D. H. Stormont

Oil-Well Pumping—35 185

By Josph Zaba

Questions on Technology 189

the OIL AND GAS JOURNAL Newsletter

Tulsa, Okla.
March 13, 1961

Another major advance in the LPG boom is in the cards:

New chapter in spectacular story of liquefied-petroleum gas will be written with establishment of an 800-mile pipeline system from Central Kansas to St. Paul-Minneapolis and Central Illinois areas.

System is planned by Northern Gas Products Co., subsidiary of Northern Natural Gas Co., and Great Lakes Pipe Line Co. (p. 90)*.

With projected capacity of 40,000 bbl. daily, new system will include seven terminals. Route closely parallels northern part of Mid-America Pipeline Co. system, nation's first major line built exclusively for LPG, which started operating only few months ago.

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Refiners keep on knocking down their own records. For the week ending March 3, runs averaged 8,474,000 bbl. daily—up 27,000 bbl. daily from the previous high chalked up during the week of February 17. Altogether, refiners have set four new records in the past 6 weeks.

Some refiners have suggested 4-week averages for refinery comparisons instead of figures for a single week. But even the 4-week average of refinery runs tops 8,000,000 bbl. daily. For the 4 weeks ending March 3, average was 8,426,000 bbl. daily—a gain of 379,000 bbl. over the same weeks last year.

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California is becoming the nation's No. 1 gas market.

Look what the figures will be when current projects finally are completed: 13,700 miles of transmission lines, costing $2.5 billion with capacity of 3.9 billion cubic feet daily. Value of the daily gas deliveries will be $1.5 million.

Five big pipeline projects now in the mill for the state will establish these trends: Give California five sources of supply, the widest base of any similar market; and stabilize the price (p. 122).

A fuel cell powered by natural gas has been put to work on a pipeline, probably the first commercial use of its kind.

The cell, a 10-watt unit, provides current for cathodic protec-

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*Refers to article in this issue giving more details. When no page is given, the item is a Newsletter exclusive.

tion for a pipeline of Northern Illinois Gas Co. Engineers give it high marks after 8 months of field testing (p. 96).

Just released: Preliminary figures on 1960 that show natural-gas output in Texas remains something to crow about.

Railroad Commission reports year saw gas-well production rise 6%. Total of gas wells in state went up 2,424 to 25,809, while number of producing wells increased 1,860 to 16,752. Slight drop of 3.3% was noted in casinghead production.

Now that natural gas has replaced crude as Texas' industrial lifeblood, oil operators are shelling out plenty of cash in hunt for more gas reserves (p. 167).

▼ ▼ ▼

Nebraska and Texas may have new producing counties.

Furnas County, Nebraska, has good prospect at Exeter Drilling Co. 1 Palmer, 3 miles northwest of Wilsonville. Well got 370 ft. of free oil and 120 ft. oil-cut mud in test at 3,366-3,445 ft. in basal Pennsylvanian sand. Well is 7 miles east of Silver Creek field.

Hood County, Texas, has apparent producer at Cities Service 1-B Allen, 2 miles northeast of Lipan. Total depth is 5,516 ft. with 4½-in. casing set to 5,200 ft. Test of Ellenburger at 5,151-71 ft. flowed 128 M.c.f. daily, dropping to 12 M.c.f. and recovery of 45 ft. free oil and 178 ft. heavy oil and gas-cut mud. Wildcat is 4 miles south of Conglomerate production and east of Bend arch.

Look for well completions on the ocean floor to become big trend in California's developing offshore oil region.

Richfield has made the first such completion. Well is three-fourths mile off Rincon Point between Ventura and Santa Barbara counties in 55 ft. of water. Production is 75 bbl. daily, flowing about 3,000 ft. through 2-in. line to drilling island.

Action is significant for California offshore operators who face trouble with civic groups in building offshore platforms and also have difficulty whipstocking wells in that area.

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A 20-well program on its 200,000-acre license is planned in Lake Erie by El Paso Natural for 1961.

Offshore Co. of Baton Rouge will convert a vessel for the job using a rotary mounted for drilling through the center of the ship. New drilling and completion techniques tested in Louisiana offshore work will be used on the lake.

First wildcat in Alaska's Bethel basin will be started by Pan American as soon as equipment arrives. Well is Napatuk Creek No. 1.

California Standard has taken permits for three more wells in Swanson River field and currently has six rigs busy on its Kenai holdings. During February, California Standard completed the 21st producer in Swanson River and Union Oil completed its fifth gas well in the Kenai gas field.

Jersey research expert's making big pitch for air drilling during tour of company's key drilling spots in North Africa and in Europe. His argument, based on 2-year study: Wider use of air drilling would spark gains in efficiency and reduce costs. Savings of up to 30% have been mentioned.

Elaborate study of earth's crust also will be undertaken by Jersey Research as soon as a new facility is built at Leonard, Okla.
Its target: Better and more direct methods of finding oil.
Jersey scientists feel the present seismic method is discouragingly inadequate in detecting many types of oil reservoirs remaining to be discovered. They think it's time to lay the foundation for an advanced new technology. Details of their approach are secret.

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Veteran marketing man predicts refiners and suppliers will depend more on jobbers in years ahead. L. T. White, Cities Service vice president, thinks jobber gives manufacturer more profit per transaction than direct method does. Biggest advantage of jobber, in White's view: He's familiar with local conditions and can mold his merchandising plans to fit them.

Sour note on the industry's travel development program:
A few newspapers that planned special automotive travel section for May 21 have decided not to participate because of lack of advertising support from petroleum companies.

President Kennedy's plan to extend temporary 1-cent tax on gasoline beyond scheduled expiration date is drawing fire.
API President Frank Porter flays proposal as "unjustified as long as $1.7 billion in highway-user taxes is being diverted to non-highway use."
Estill Heyser, Jr., head of Texas Mid-Continent Oil and Gas Association, issues this warning to motorists: Beware of Kennedy's "financial sleight of hand" in highway financing. Adds Heyser: It's up to consumers to see that Congress "does not renege on its promise to cut the federal tax on gasoline to 3 cents a gallon on June 30."

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Labor fill-in: New plan to fight national unemployment is offered by OCAW President O. A. Knight, who proposes federal law that would automatically cut work hours any time Bureau of Labor Standards sounds alarm on number of jobless. Take-home pay would stay the same or even be raised, however...OCAW agrees with oil industry that all automotive taxes should be channeled into roadbuilding and that current 40% drain-off for other purposes should be stopped. Do this, union says, and it won't be necessary to raise gasoline tax... Labor chieftains aren't looking for early settlement of strike at Phillips plants in Borger, Dumas, and Pasadena, Tex., over OCAW's demand for right to bargain on benefit plans.

Market Memo

March 13, 1961

Dark patches are developing in petroleum markets as the between-season lull continues.

Gasoline remains mostly unchanged, although there are rumors that it could be discounted on a firm offer in the Gulf Coast area. No. 2 is definitely weakening.

Spotty discounts on heating oil that have prevailed all winter in the New England and Baltimore areas have deepened. And New York Harbor prices are showing signs of shakiness as the suppliers with surplus oil in storage get more nervous about getting rid of it.

Warm weather's the trouble in the East. Suppliers are thinking more and more in terms of small discounts to beat a wide general price break. However, a sudden cold spell could delay a major cut.

On the Gulf Coast, foot-dragging and other circumstances that have hurt No. 2 for weeks have dimmed the short-range outlook. Posted price is hanging at 9.5 cents, but buyers probably could make deals for 9 cents per gallon.

One hopeful note: It doesn't look as if the Gulf Coast price would break ahead of the East's.

Except for a trickle of gasoline inquiries from upriver buyers, the Mississippi River market is keeping its look of suspended animation. These queries may be a probing for soft spots, however, rather than an expression of real interest.

The Great Lakes and Mid-Continent profiles show little change. Most spot gasoline moving on the Great Lakes Pipe Line is going at a discount of one-half cent under the 12.5-cent posting.

Something drastic had better be done—and quickly—about high refinery runs. With gasoline stocks at 221 million barrels at the end of February, nearly as high as 222.7 million at the end of March last year, the situation's getting ridiculous. And risky. Just one refiner could kick off a season of soft markets if he were tempted to cut prices at the start of the motoring months in order to make spot sales. Sensible solution: Let refiners start tailoring runs to anticipated demand right now (p. 87).

Marketing notes: New use of clear plastic film—a waterproof envelope for mailing printed matter. Koppers Co. used them effectively in mailing its annual reports...Marketers in farm areas will be interested in this Ford Motor prediction: Farm tractors in next 10 years will grow more powerful to work the bigger farms. Farm size by 1970 will grow from present 290-acre average to 350. Belt horsepower of average farm tractor will grow from 47 to 60.

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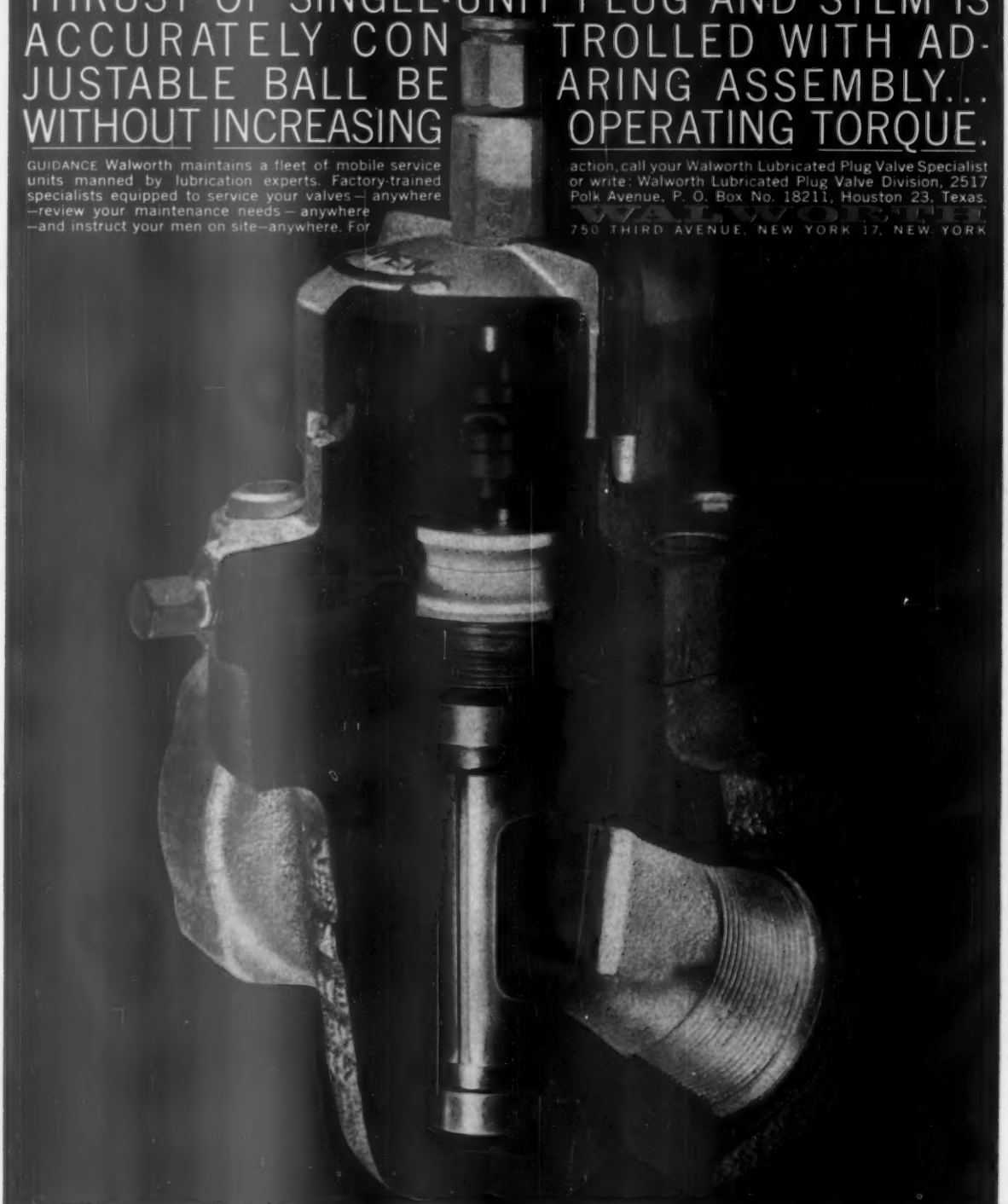

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C-B/Southern's experience extends through Design, Engineering and Manufacturing Departments. It reaches all the way to future service from 22 Cooper-Bessemer service offices.

A point worth remembering: C-B/S packaged compressor plants are available in horsepower ratings from 100 to 1440; unitized compressors, both reciprocating and centrifugal, to 10,500 horsepower.

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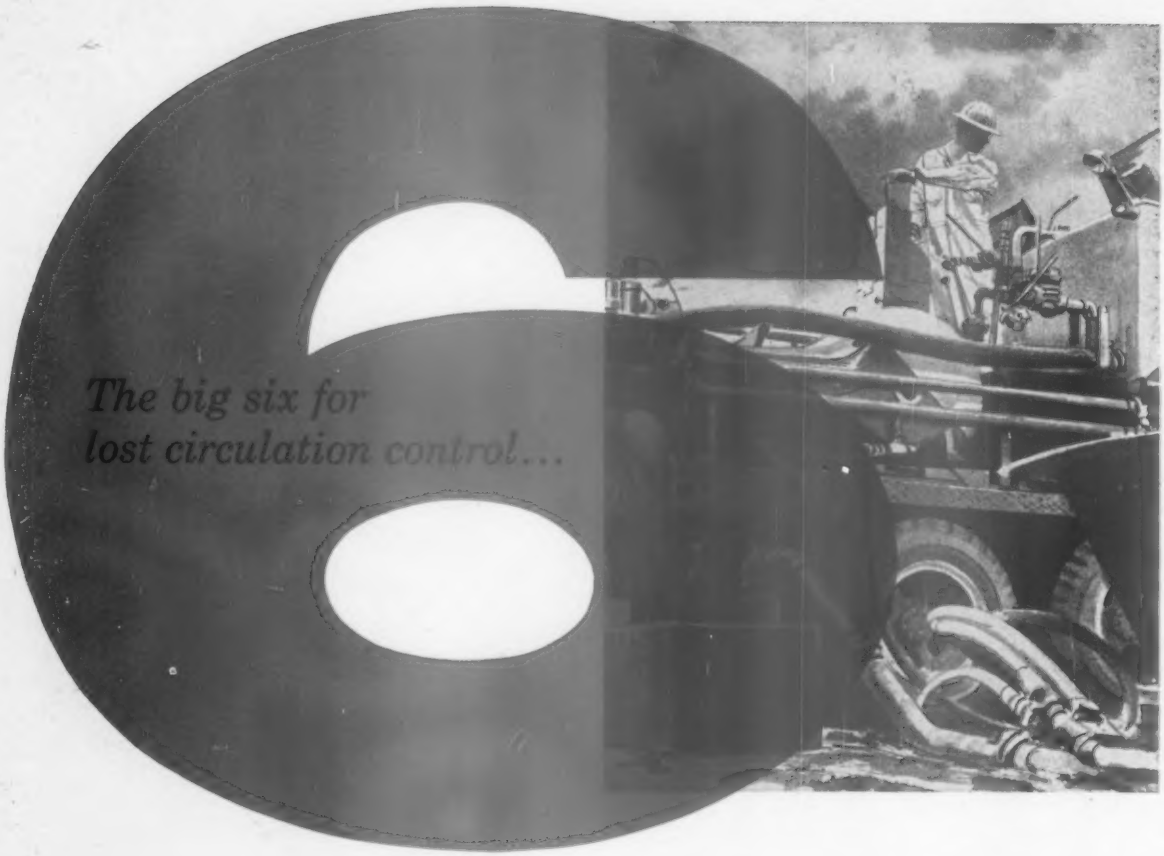

"Stop-loss" techniques and materials for almost every lost circulation problem...

There is no single solution to all lost circulation problems . . . as lost circulation, a continuing loss of drilling fluid or cement into excessively permeable formations, crevices, fissures or vugs may result from a variety of causes. Halliburton offers six basic "stop-loss" techniques that restrict such losses to a minimum – in virtually all types of formations:

1. Plugging with quick-setting cements and resins which set up while flowing into and through channels.
2. Squeezing with special material which builds up viscosity until it becomes a stiff gel, which can then be extruded.
3. Squeezing with an easily pumpable fluid that maintains a low viscosity until it starts to set. A very stiff gel is then formed in a few minutes.
4. Blocking circulation loss channels with flaky, fibrous, granular or gelling additives to drilling mud or cement.
5. Blocking with special slurry which thickens by hydration. Waterless slurry is pumped to thief zone of well, then hydrated.
6. Lightening the column of drilling fluid or cement slurry to decrease the pressure which forces it into formation. This technique may be combined with bulk blocking materials.

Halliburton "stop-loss" techniques are designed to help solve *your* lost circulation problems. Don't go on losing drilling dollars when a call to the Halliburton representative in your area takes but a minute and may make a real difference in the profitable operation of your well.

Effective "stop-loss" techniques result from effective materials such as these...

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Gilsonite—A new granular additive for all types of cementing compositions, with excellent lost circulation control characteristics through reduction of slurry density and outstanding bridging properties. With a specific gravity of 1.07, Gilsonite adds volume, not weight, to cement slurry, resulting in light weight slurries having high compressive strength at low temperatures. 25 to 50 lbs. per sack of cementitious material is generally an optimum amount required. Resistant to water and brine corrosion and to attacks of acids or alkalies; has a high insulating value against electric currents. Gilsonite may be used with portland cement with or without bentonite, Pozmix Cement or Pozmix 140.

FOR PLUGGING...

Cal-Seal with Portland Cement—Mixed with portland cement, Cal-Seal, a super-strength gypsum cement, sets quicker and aids in sealing off circulation loss zones of shallow depths where temperatures are relatively low. For higher temperatures, straight portland cement with or without Halliburton HA-5 Accelerator sets quicker and is often more effective for Lost Circulation.

Hydro-Lok (PC-11) and (HG-10)—Originally developed as water control agents, Hydro-Lok materials have been used successfully many times to control troublesome lost circulation conditions in naturally fractured formations. These Hydro-Lok materials are insoluble in acids and well fluids. Hydro-Lok (PC-11) is a plastic slurry consisting of a resin mix and inert solids; HG-10 is the resin material alone.

FOR SQUEEZING...

Hydro-Lok (PWG)—Unset Hydro-Lok (PWG) is a low viscosity fluid and this viscosity is maintained throughout 95% of its pumping life. When PWG enters its setting phase, a very stiff gel is formed in a few minutes. Such a material has given successful results in certain problems of lost circulation. The setting of PWG can be adjusted to fit formation temperatures between 32° and 200°F.

FOR BLOCKING...

Tuf-Plug—A special blend of graded ground walnut shell used as an additive in drilling fluid or cement, Tuf-Plug often provides an effective seal to shut off wide fractures... its strength helps support high columns of cement behind the pipe.

Diesel Oil Cement (DOC)—Diesel Oil Cement is a mixture of portland cement, diesel oil and an effective chemical dispersant. Pumped to a thief zone, DOC slurry quickly thickens... the water penetrated slurry will then set to give a stronger and more permanent plug than many other lost circulation materials. Particularly effective for fractured conditions and in difficult zones of very high permeability. Small cavities may also be plugged.

Flocele—Flocele is a chemically inert cellulose film flake which, when added to cement slurries, does not affect pumping or setting properties, yet effectively bridges and seals most fissures and other thief zones. It helps prevent or lessen the loss of expensive cement or drilling fluid into many permeable formations during casing cementing. Economical, too, since normally 1% or less of Flocele is sufficient. ⅜" flakes are recommended for use in cement and ¾" flakes in drilling fluids.

Bentonite Diesel Oil (BDO)—A thin slurry of bentonite in diesel oil... pumped down the drill pipe to mix with the drilling mud forms a sticky, putty-like material that usually plasters over the zone and helps shut off circulation loss permeability.

and an efficient tool...

Open Hole Treating Packer—For treating lost circulation zones in open holes, with just one trip into the hole. Can be set, moved and re-set until zone is pin-pointed, then blocking agent is placed through same packer. Lengthy anchor is not necessary because lateral expanding slip assembly makes this unique packer completely independent of the distance from the bottom of the hole.

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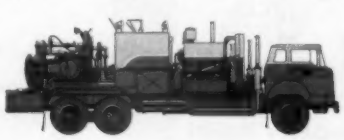

Fine Products

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Mid-Continent Supply Co. store at Harvey, Louisiana.

Interior view of Sterling, Colorado warehouse of Bethlehem Steel Company Supply Division.

Havenscville, Illinois, store of The National Supply Company.

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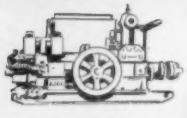

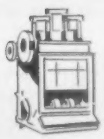

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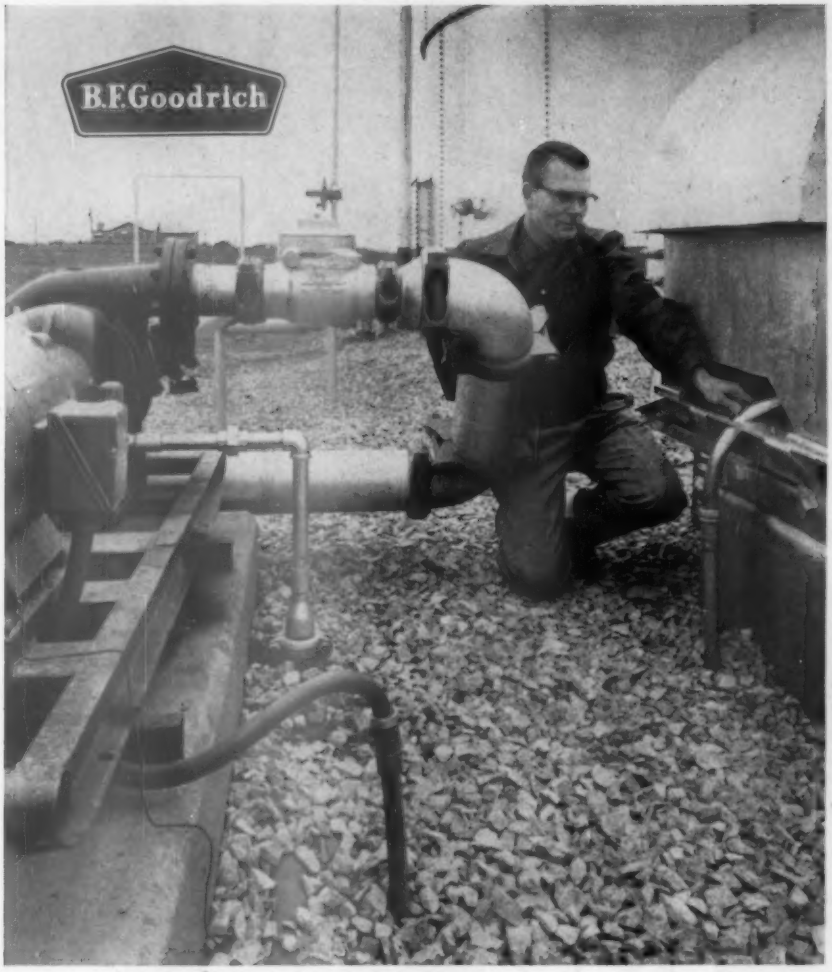

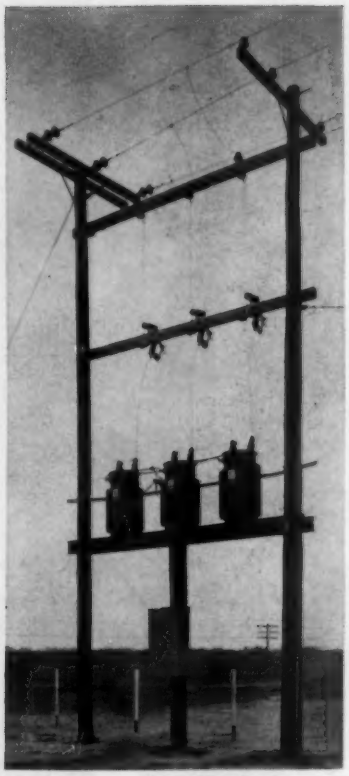

Lloyd Thomas Electrical, of Austin, Texas, installed the rigid conduit shown here at the Pierce Lease of Cities Service Oil Co., about five miles south of Electra, Texas. The Kraloy Rigid PVC Conduit and fittings are manufactured by Kraloy/Chemtrol Co., Electrical Conduit Division, Santa Ana, California, using rigid Geon supplied by B.F.Goodrich Chemical Company.

Electrical contractor reports:

Conduit of rigid Geon solves salt water corrosion problem in flooding operations

Secondary recovery operations in Texas oil fields involve the injection of salt water under pressure into oil formations. This salt water can cause a real corrosion problem with metallic conduit, resulting in short circuits and costly shutdowns. The solution: Conduit made of rigid Geon vinyl.

"Using metal conduit, an installation rarely lasts more than six months," the contractor says. "In fact, we've had instances of short circuits in as short a time as six weeks. However, it is more than a year since we made our first installation of rigid Geon and there has been no need for repair or replacement."

Rigid Geon not only resists most causes of corrosion, it gives conduit impact resistance and tensile strength. It is lightweight, easy to install. Crews like to work with it.

Here's another way rigid Geon is helping to solve application problems — making possible new products and new markets. For more information, write Department NL-2, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. In Canada: Kitchener, Ontario.

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Midwest stocks chrome-moly fittings in all standard types, sizes and wall thicknesses—cutting costly downtime to a minimum.

And, if the fitting you need is *not* standard, it can be produced quickly from the full stocks of raw materials maintained by Midwest.

When you need replacement fittings, get back on stream fast! Call your Midwest distributor for quick, dependable delivery and service.

MIDWEST PIPING CO. INC.
1450 S. SECOND ST., ST. LOUIS 4, MO.

6109

NEW FROM GASO

Gaso Fig. 3467 — 1¼" to 2" x 4" Horizontal Triplex Plunger Pump with Single-Suction.

CAPACITY, PRESSURE, POWER CHART

Plunger Size	DISPLACEMENT Barrels per Hour		Maximum Working Pressure P.S.I.	HORSEPOWER REQUIRED at Maximum Speed & P.S.I.
	100 RPM	350 RPM*		
1¼"	9.0	31.5	3500	50
1½"	13.3	46.5	3250	68
1¾"	18.0	63.0	2500	71
2"	23.1	81.0	2000	73

*Maximum RPM of Crankshaft

Fig. 3467, featuring a new high pressure fluid end for use with small size plungers, brings the economies of single suction and the advantages of high pressures to small-volume water flood projects and well servicing operations. The results in terms of performance are shown in the accompanying chart.

Adaptable to Any Service Conditions

Fluid end body may be of aluminum alloy bronze or alloy steel. Suction and discharge valve assembly may be of the stem-guided monel metal disc type, or of Durabla stainless steel. All plunger sizes are available in hardened stainless or specially surfaced steels; ceramic plungers are available in the 1½", 1¾" and 2" sizes only.

Consult Us for Recommendations

Our engineering and sales staffs are always eager to work with you in obtaining maximum pumping results. Why not let them recommend the most effective application of the new Fig. 3467 Triplex Plunger Pump to your needs?

DISTRIBUTORS

Farmington, N. M.—Gaso Pump & Burner Mfg. Co.
Shreveport, La., Odessa, Texas, Brookhaven and Tinsley, Miss.—W. L. Somner Company
Houston, Texas—Texas Pump & Compressor Company
Wichita Falls, Texas—Pump Engineering Co.
Evansville, Indiana—Hague Equipment Co., Inc.
Long Beach and Bakersfield, Calif.—Power Pumps, Inc.
Casper, Wyoming—Lufkin Foundry & Machine Co.
Jackson, Mich.—Midway Supply Co.
Edmonton, Alberta—Lufkin Machine Co., Ltd.

GASO PUMPS
for every oil industry need

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TOYO KANETSU SETS A NEW RECORD

200

TUBESEALS

TOYO KANETSU, Japan's leading fabricator of steel plate vessels and licensee for Hammond Tubeseal Systems*, sets a new record for Tubeseal installations throughout the Far East... more than 200, ranging in capacity from less than 2,000 barrels to more than 315,000 barrels for safe storage of gasoline, petrochemicals and other volatile products.

At least 25 of these 200 Tubeseals have a capacity of 150,000 barrels, or more. *Patented

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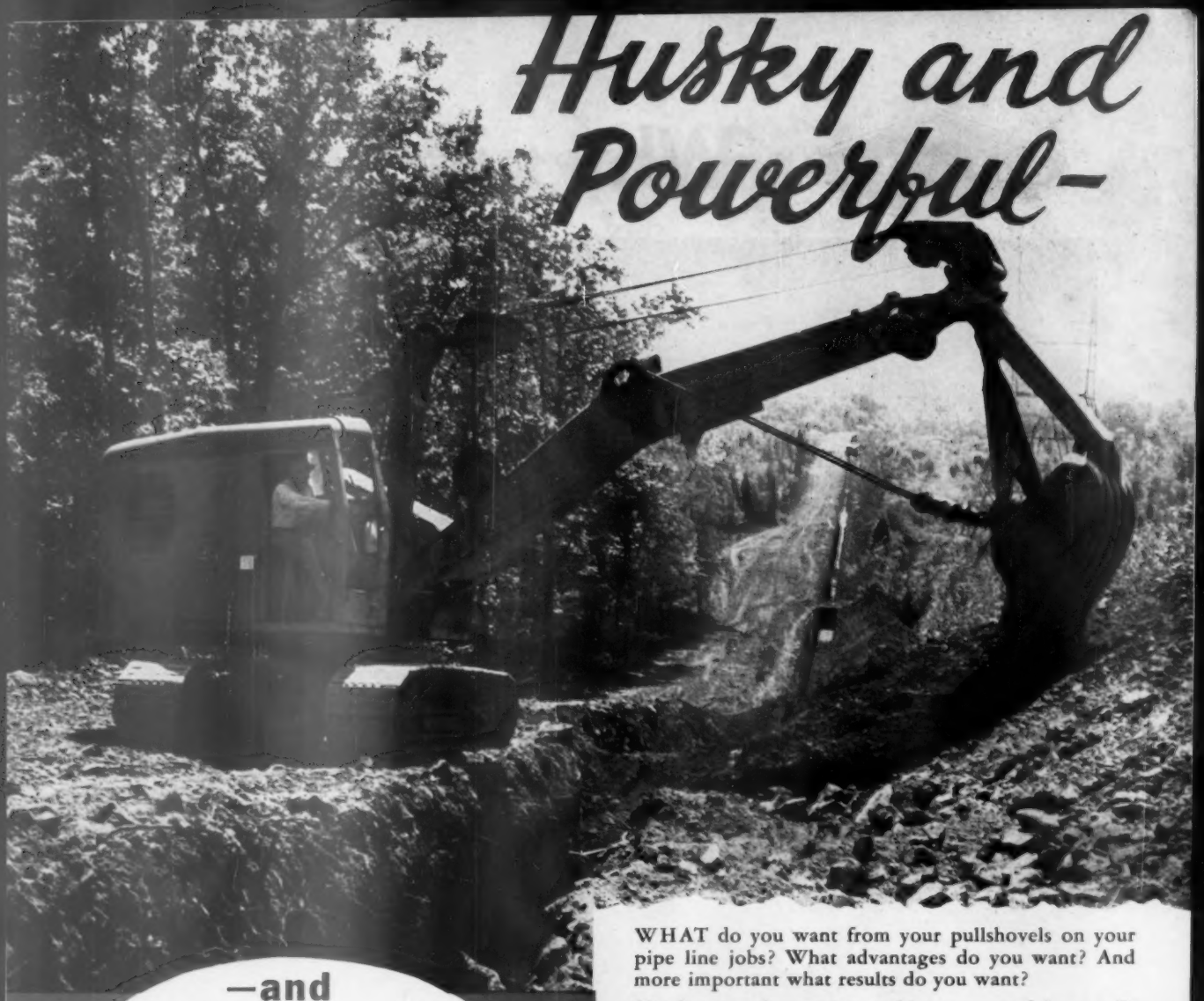

—and everything you need for *PROFITABLY* trenching the pipeline

WHAT do you want from your pullshovels on your pipe line jobs? What advantages do you want? And more important what results do you want?

Northwests give you everything you need in a pullshovel for the pipe line job. You have a choice of standard or Tractor Type Crawlers with special high clearance.

You can have standard or Two Speed Travel. On the larger Northwests you can have Positive Traction on both crawlers while turning as well as when going straight ahead or Block and Skid steering.

Northwest Pullshovels bring you the weight and power to handle digging that lighter rigs of the same rating can't handle. They have chunked out digging that has stopped other machines. Nothing is needed to hold a Northwest dipper in the cut.

Northwest Uniform Pressure Swing Clutches are large, cool running! They eliminate jerk and grabs and easily hold the dipper against the trench wall when trimming.

The Feather Touch Clutch Control gives the "true" feel of the load for the accurate handling in setting pipe.

Behind this is the Northwest record for dependability. Your Northwest is always ready to go! We hear it everywhere and Northwest users will tell you so.

These things combine to get the job finished more quickly! There are other features to tell you about. Why not get the whole story from a Northwest man?

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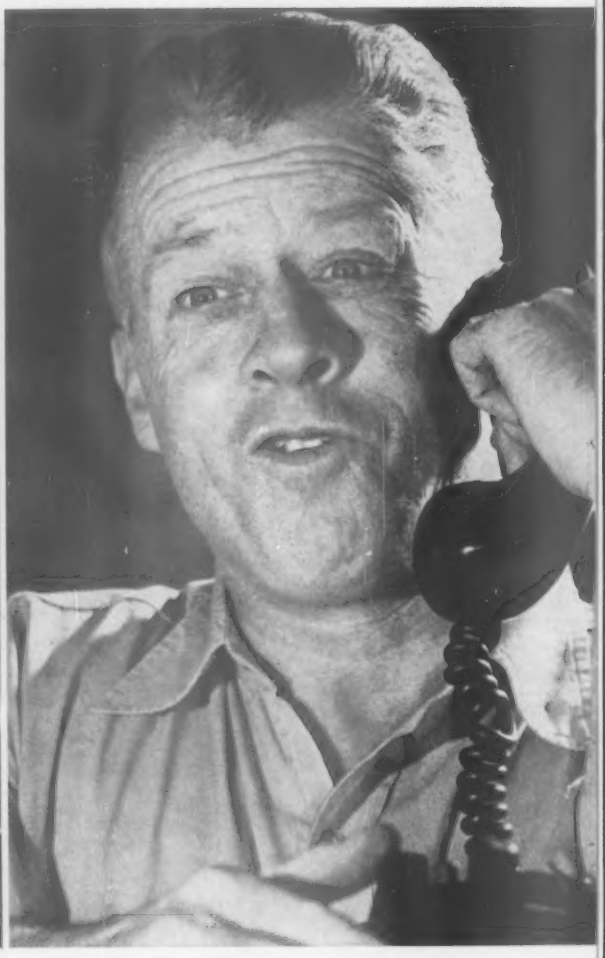
P-25-30-LC

GOODYEAR

Why not buy hose



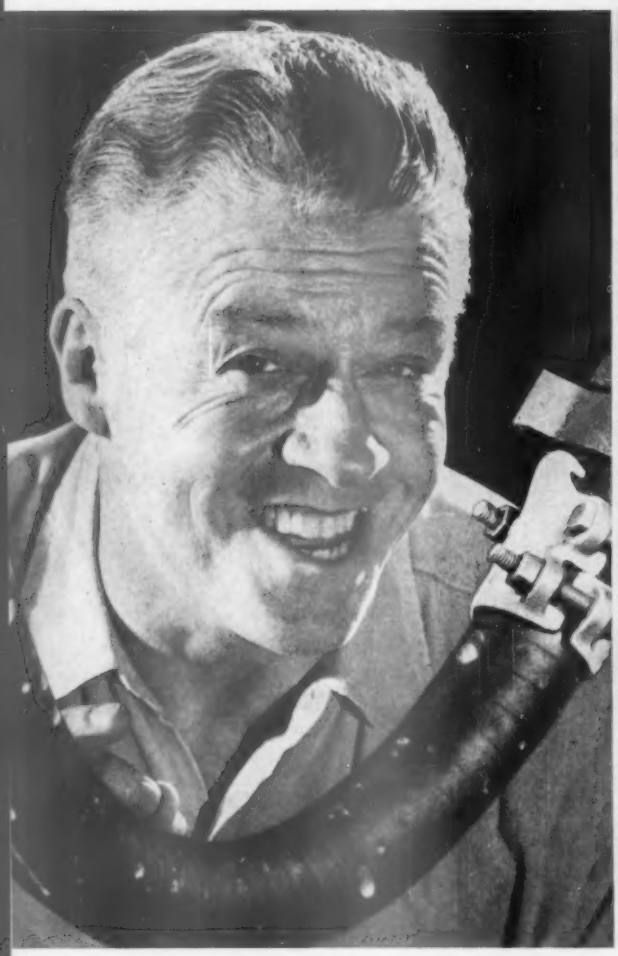
YOU GET THE RIGHT HOSE
(With the world's largest, most diversified line of industrial hose to choose from, *it's easy with Goodyear!)*

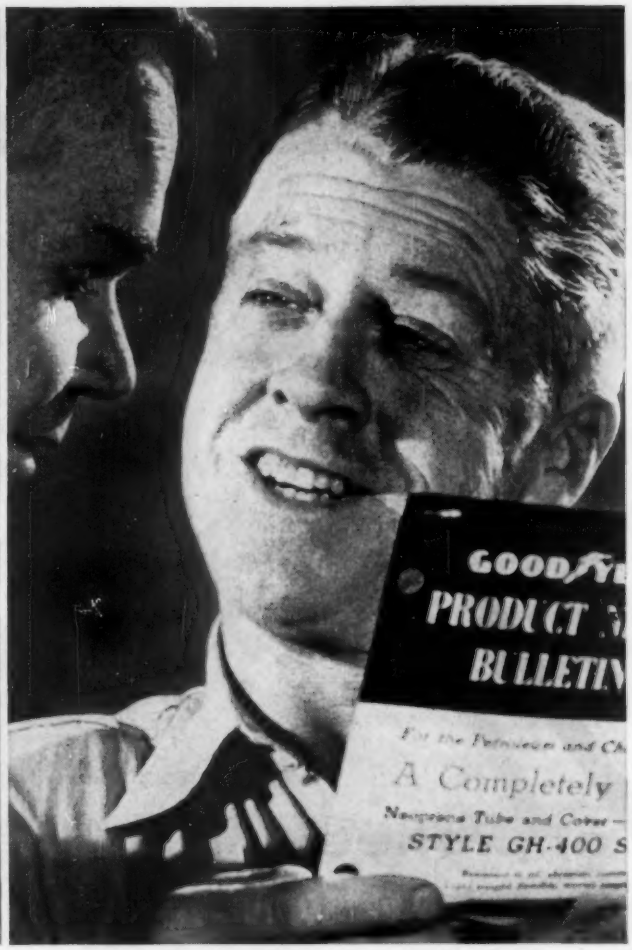
YOU GET FAST DELIVERIES
(With a big, nationwide network of stocking distributors to serve your needs, *it's easy with Goodyear!)*

For the right hose... at the right place... at your Goodyear Distributor... first in service

Lots of good things come from GOOD

the easy, Goodyear way?





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(With more than 50 years of pioneering research and development backing hose quality, *it's easy with Goodyear!)*

YOU GET EXPERT ADVICE
(With a trained hose expert like the G.T.M. – Goodyear Technical Man – always on call, *it's easy with Goodyear!)*

the right time... at the right price... call with all industrial rubber products

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GOODYEAR INDUSTRIAL PRODUCTS

70 years

of pioneering in steel pipe and tube

- **ALL TYPES OF LINE-PIPE**

  Butt welded API line-pipe from 1/4" up to 3"
  E R W API line-pipe from 1/4" up to 16"
  Cold expanded submerged arc welded
  API line-pipe from 20" up to 40".
  Spiral welded line-pipe with or without inside bea
  from 6" up to 40".

- Kindly refer to the Composite Catalog *(pages 1376 A-D).*
- Agents all over the world.
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The advanced triangular TRI▲SCOPE DERRICK!

Replaces the Double Pole Mast where it is desirable to pull doubles for rod and tubing work.

HANG RODS • RACK PIPE

Greater speed with features such as automatically positioning rod and stacking boards. Top section automatically locks into position.

GREATER STRENGTH

Triangular construction gives greater strength with less weight. Rated 100,000# with 2-to-1 safety factor. 90′ derrick.

LESS GUYING

Minimum guying required for wind protection only. Rigs up faster than clumsy 87 ft. double pole.

HYDRAULICALLY RAISED POWER EXTENDED

Single hydraulic ram raises mast. Excellent visibility adds to many other safety features.

Call your Franks representative for the exciting details, or write for specifications folder

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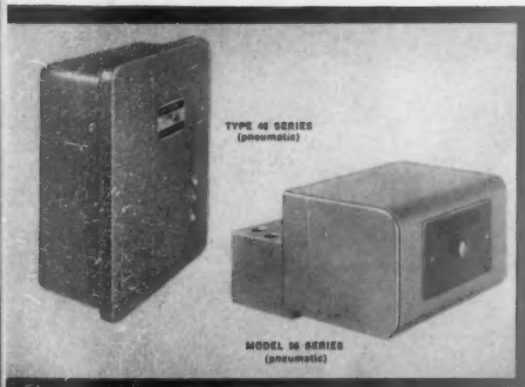
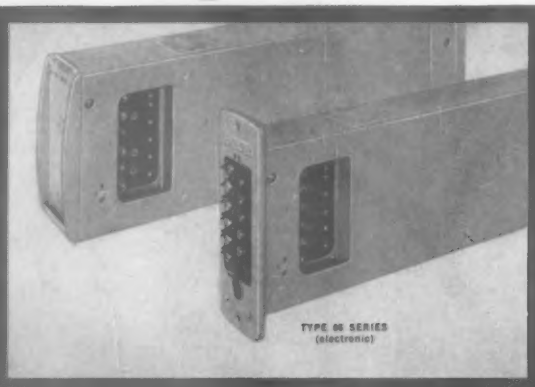
CABOT CORPORATION
MACHINERY DIVISION

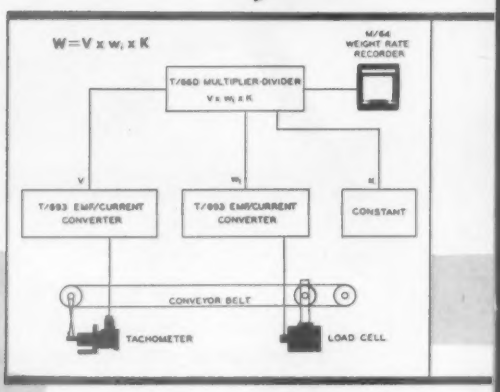
new low-cost Foxboro simplify automation





FOXBORO ANALOG COMPUTING STATIONS

▶ **TYPICAL**



WEIGHT RATE COMPUTATION

Gives operator continuous recording of actual weight of materials being conveyed by belt. For example, T/66D Multiplier-Divider calculates actual weight-rate from load cell and belt speed measurements.

Analog Computing Systems of process mathematics

both pneumatic and electronic units available

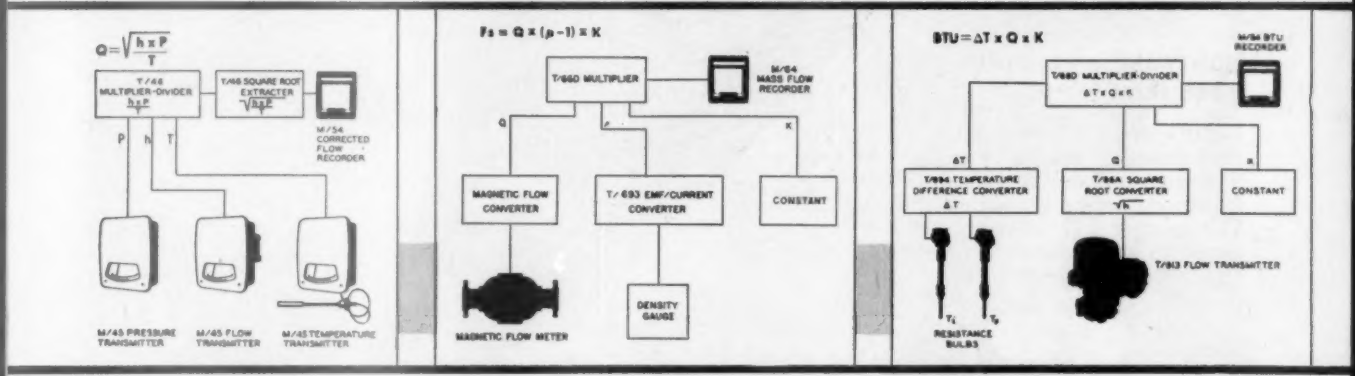
Analog computing systems have been known and used for years. Yet their potential for increasing process efficiency has hardly been scratched.

Just look what they can do! Continuous calculation of all the arithmetic functions: addition, subtraction, multiplication, division, square root extraction — in any combination. And all done automatically by a single packaged system.

And look how it simplifies the operator's job. Instantaneous calculation . . . with records to prove it. No slide rules, no interpolation, no planimeters — and most important — no mistakes.

Because Foxboro Analog Computer Systems are relatively low-cost ($2500-5000 average) you can "spot" them about your plant for maximum efficiency. Or, they can be grouped together at a central location to solve more complicated equations. Pneumatic and electronic systems available.

CALCULATIONS MADE WITH FOXBORO ANALOG COMPUTING SYSTEMS



GAS FLOW COMPUTATION

In common use in the Gas Industry to compensate gas flow readings for changes in line temperature and static pressure. In the pneumatic system shown here, the Foxboro T/46 Multiplier-Divider and the Square Root Extractor allow operator to read corrected flow directly.

MASS FLOW COMPUTATION

Calculates dry weight of a slurry flowing through a pipeline. In this electronic system, flow rate and density measurement are multiplied together with a Foxboro T/66D-1 Multiplier. Operator can then read flow directly in Dry-Tons-Per-Minute.

BTU COMPUTATION

Determines actual amount of heat being introduced to, or removed from, a process. Electronic system shown uses a Foxboro T/66D Multiplier-Divider to produce a signal equal to product of flow and temperature difference. Operator reads directly in Btu's.

WHAT CALCULATIONS WOULD YOU LIKE TO AUTOMATE? ➔

FOXBORO
REG. U. S. PAT. OFF.

The Foxboro Company, 603 Neponset Ave.
Foxboro, Mass.

I have a process computation I should like to automate. Can a Foxboro Analog Computing System do it for me?

My process is.....

I want to compute.....

.....

Name.....

Position.....

Company.....

Address.....

City.....**State**.....

ON THE LINE OR IN THE HOLE

STANDS FOR SAVINGS AND PROFITS

LIGHTWALL... LESS WEIGHT... MORE FLOW-THROUGH

Southwestern Lightwall has *earned* its reputation as the profit-pipe — earned it through greater savings in initial cost, transportation and handling, installation. The greater I.D. of Lightwall — compared to standard wall — means more flow-through, higher profits.

BIG SAVINGS IN SLIM HOLE AND MULTI-ZONE COMPLETIONS

High-quality Southwestern integral-joint tubing can save up to 30% as compared to conventional completion costs. Southwestern tubing conforms to applicable parts of API 5A standards and is interchangeable with API 10Rd. non-upset tubing. Send for our brochure with complete specifications.

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Sales Offices In Midland, Dallas and Tulsa

SOUTHWESTERN PIPE, INC.

P. O. BOX 2002 HOUSTON 1, TEXAS PHONE CAPITOL 4-0631

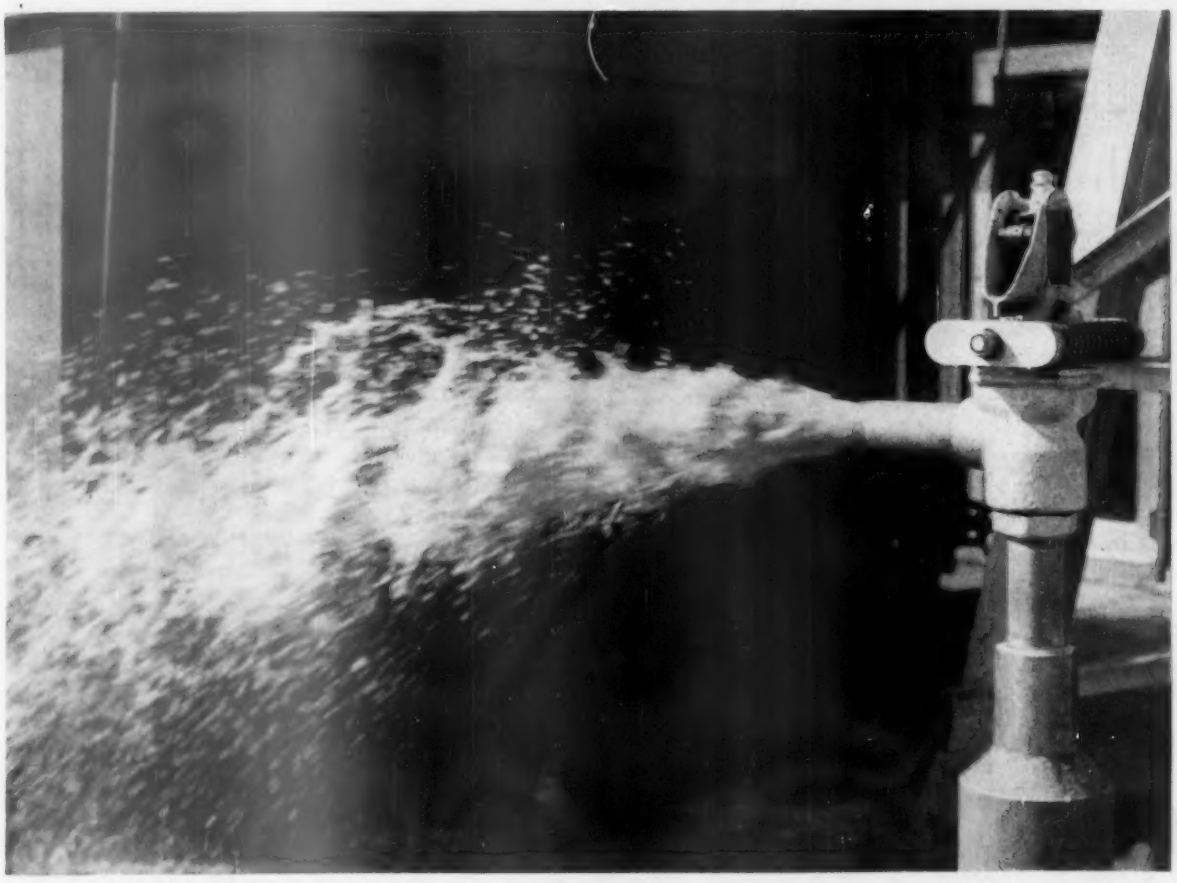
The Cameron Type "A" Reset Relief Valve is a brand new idea – an entirely new type of pressure relief valve. This valve, instantly adjustable in service to the desired relief pressure clearly shown on a calibrated scale, *opens fully* when the pressure exceeds that point and remains fully open until it is manually reset. Abrasive fluids and slurries are no problem because there is no throttling, no leakage, no wire drawing, no cutting – the valve is either fully closed or, instantly, fully open. No special tools and little effort is required for resetting. Operating of the reset lever merely returns the linkage to the set position and does not have to overcome compression of springs.

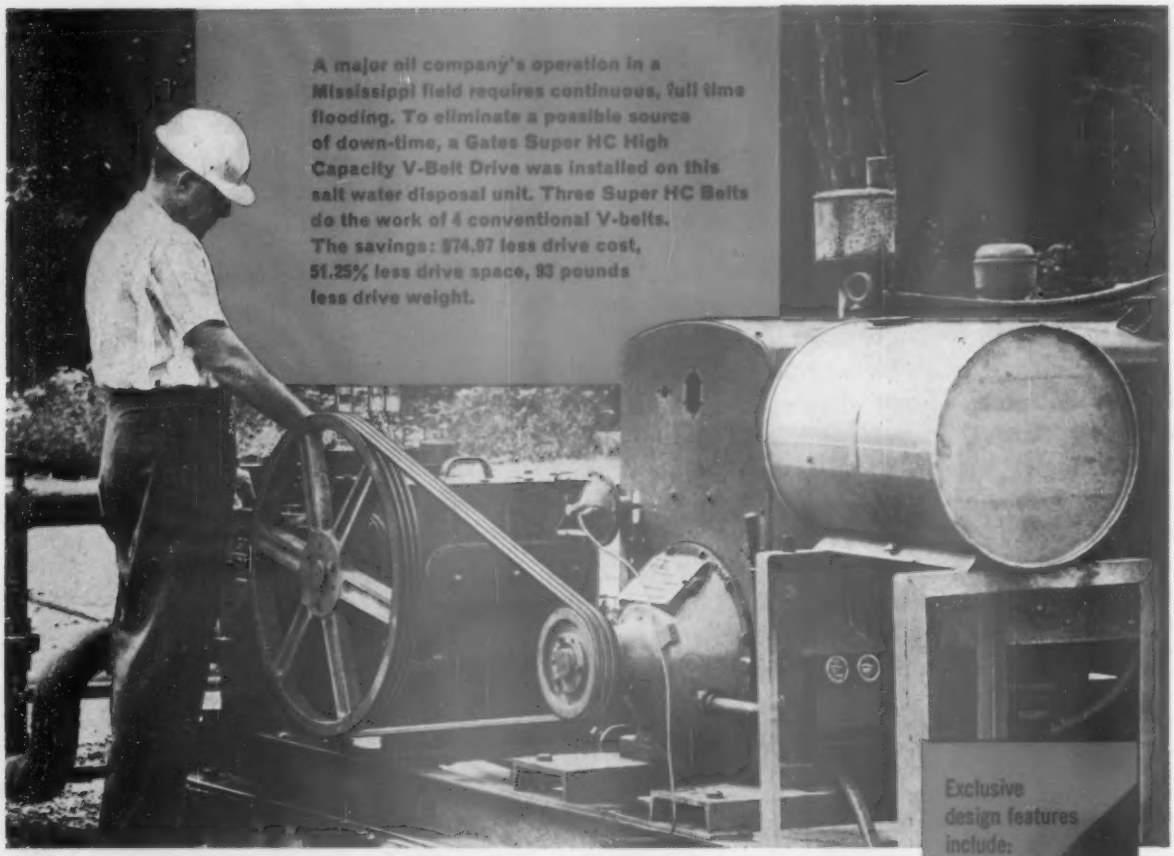
The Cameron Type "A" Reset Relief Valve assures unequaled safety, performance and economy through these advantages: 1. Continuously adjustable to relieve at any pressure within range – 1500 to 5000 psi or 750 to 2500 psi. 2. Opens full – no throttling effect or wire drawing. Piston moves clear and stays clear until valve is manually reset. 3. Single setting nut easily adjusts to exact relief point, clearly shown by a pointer and a calibrated scale – even with pressure in the valve. 4. Surging pressure, vibration or extended operation does not affect accuracy of setting. 5. Moving a single lever resets the valve, no shear pins or special tools are required. 6. Complete safety in operation – no unguarded moving parts – no flying pieces of shear pins. 7. A release button provides quick, easy discharge at any time, regardless of line pressure. A light tap with hammer will discharge it at maximum pressure.

Cameron

CAMERON IRON WORKS, INC.
P. O. BOX 1212 HOUSTON, TEXAS

POSITIVE PRESSURE PROTECTION





A major oil company's operation in a Mississippi field requires continuous, full time flooding. To eliminate a possible source of down-time, a Gates Super HC High Capacity V-Belt Drive was installed on this salt water disposal unit. Three Super HC Belts do the work of 4 conventional V-belts. The savings: $74.97 less drive cost, 51.25% less drive space, 93 pounds less drive weight.

Transmit greater power in less space with Gates High Capacity V-Belt Drives

Because of basic changes in V-belt shape and construction, Gates Super HC High Capacity V-Belts handle up to 3 times greater horsepower than conventional V-belts in the same drive space. Therefore, the Gates drive can be more compact than a conventional V-belt drive, handling the same power in about half the space.

With Gates Super HC Drives, fewer belts are needed. Sheaves can be smaller and lighter in weight. Bearing loads are less. Center distances can often be reduced. Guards and machine housings can be smaller. Shafts can be shorter. Drive costs are often cut as much as 20%. Shipping weight is less. Furthermore, the drive can operate at belt speeds up to 6,000 ft/min without dynamic balancing. This permits use of higher rpm motors—with savings in motor costs.

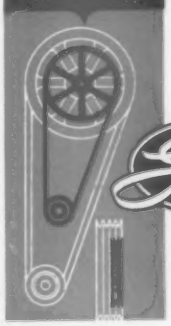
The Gates Super HC V-Belt Drive is in use the world over on all types of equipment. It is the first and most advanced high capacity drive, and it is your best assurance that your power transmission units will not soon become obsolete.

There is a Gates Field Engineer serving your area. To contact him, and to get complete information about the Super HC Drive, call your nearby Gates-stocked supply house.

Exclusive design features include:

precisely engineered arched top, concave sidewalls, Flex-Weave cover, super strength tensile construction.

Gates Super HC Drive saves space, weight and money



The Gates Rubber Company, Denver, Colorado BP 24

Gates Super HC V-Belt Drives

Gates

Building the future on 50 years of progress.

"We've been using Edward Mudwonder Valves for six years . . ."

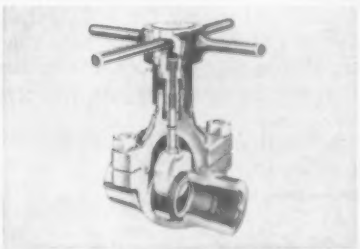
SAYS HOMER SMITH,
MARINE SUPERINTENDENT,
M & M DRILLING CO.,
HOUSTON, TEXAS

"Inshore drilling is our speciality. We've been drilling all over the Louisiana Gulf-Coast for over twenty years.

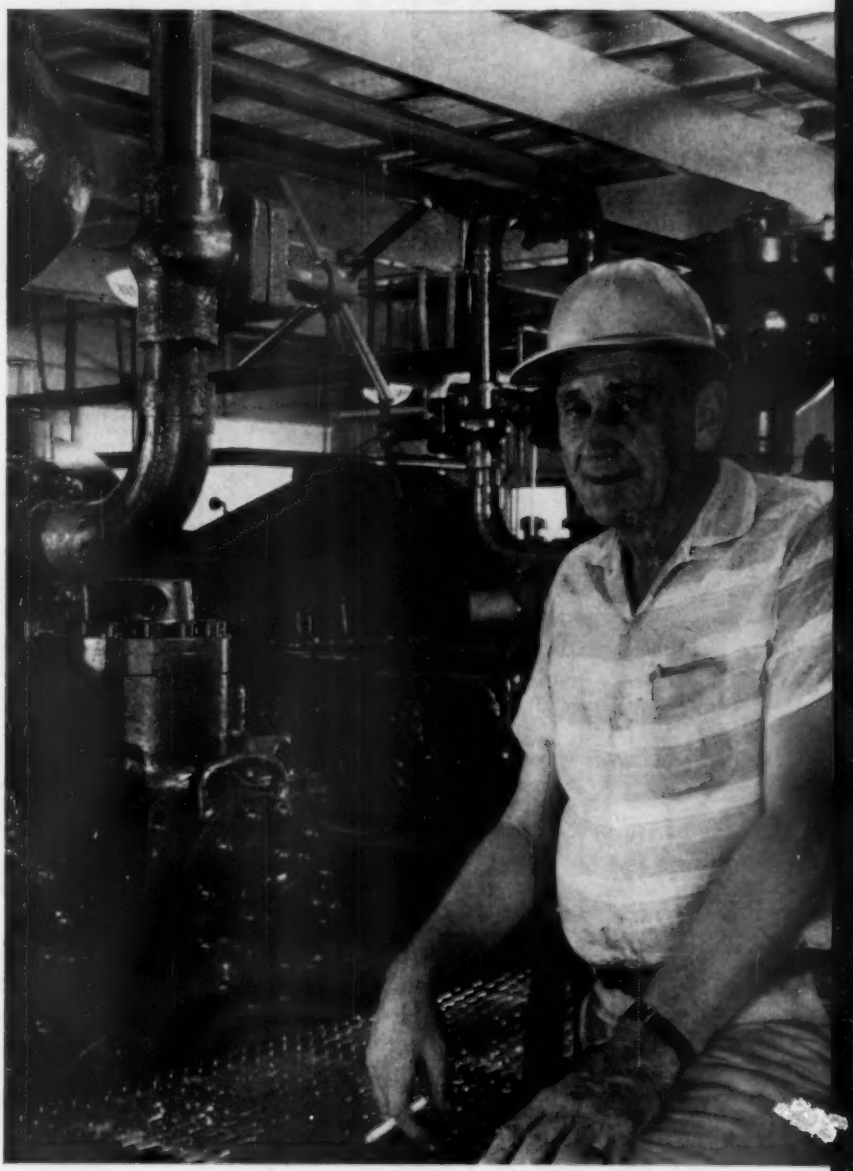
"As you can see from our new Barge #2, we have no small investment in equipment. This new diesel electric barge, for example, was specially designed with a raised deck. It's capable of drilling in 18 feet of water compared to the usual 12 feet for rigs of this type. And we can go down to 20,000 feet,so we are ready for any assignment that comes along.

"Naturally, when you work with equipment like this you want to go first class all the way. That's why we've been using Edward Mudwonders for the past six years and why we use them on Barge #2."

M & M Drilling Company's confidence in Edward Mudwonder valves is part of the drilling industry's growing concern for improved technology and economy. Mudwonder valves are built in 2", 3" and 4" sizes, with screwed or flanged ends, for 2000 psi WP (4000 psi test), 3000 psi WP (6000 psi test) and 5000 psi WP (10,000 psi test) service. See your favorite oil field supply store, or write Edward Valves, Inc., East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. 6022

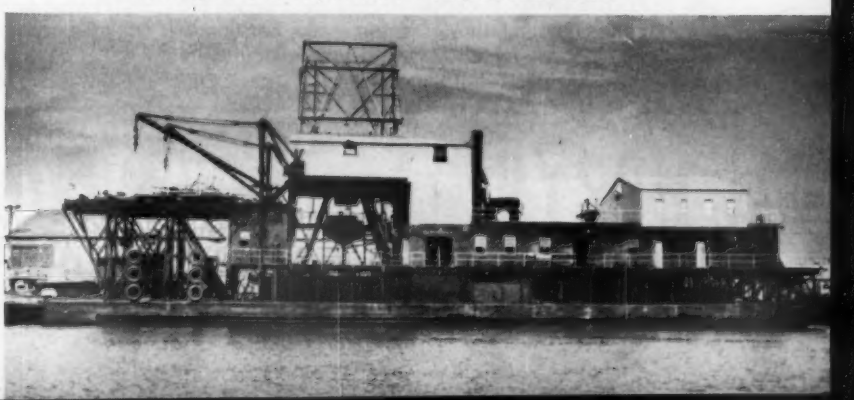


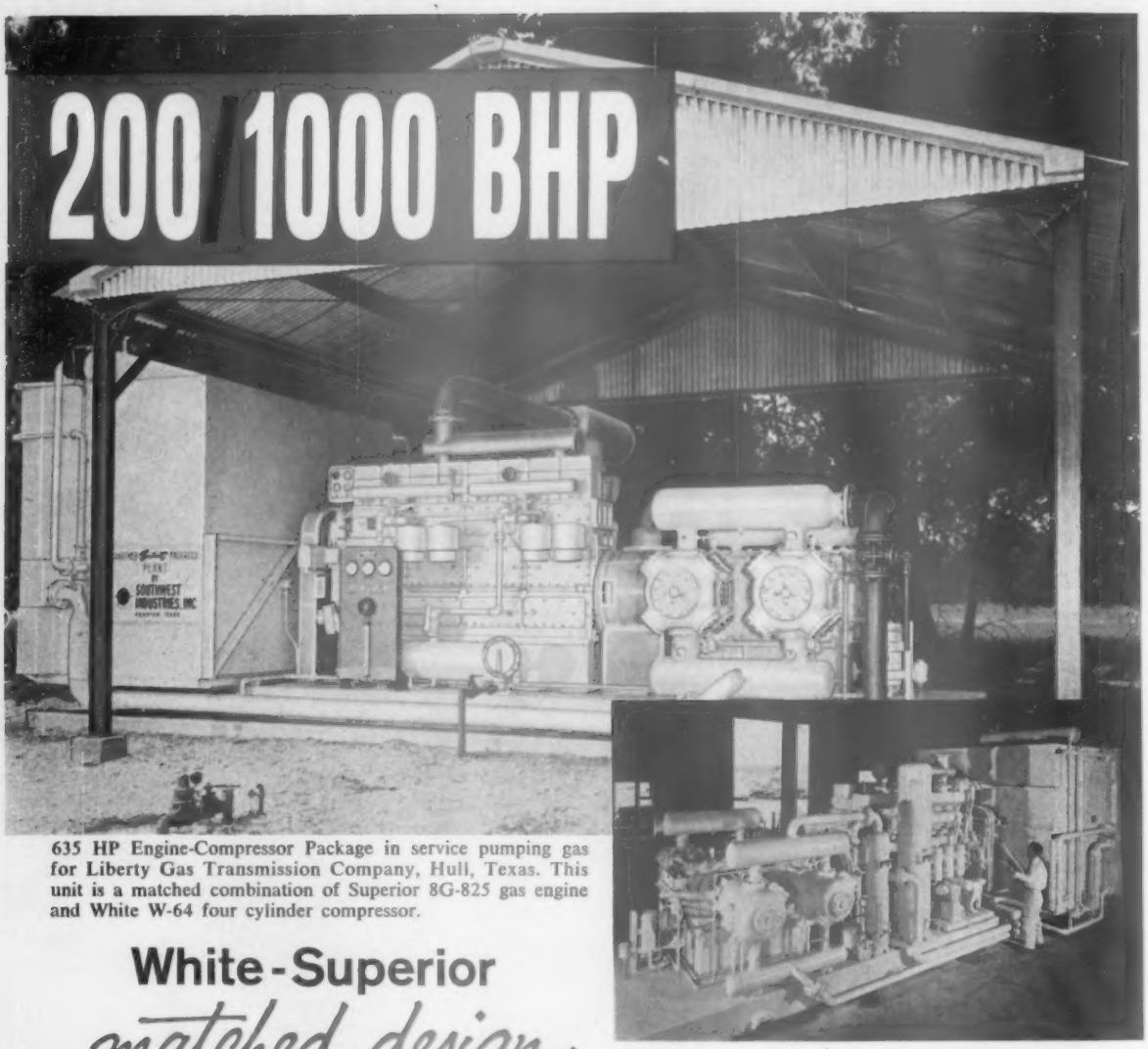
EDWARD STEEL VALVES
another fine product by
ROCKWELL



▲ Marine Superintendent Homer Smith at the manifold of Barge #2.

▼ M & M Drilling Company's new raised-deck Barge #2 can drill in water depths to 18 feet, instead of merely the usual 12 feet.





635 HP Engine-Compressor Package in service pumping gas for Liberty Gas Transmission Company, Hull, Texas. This unit is a matched combination of Superior 8G-825 gas engine and White W-64 four cylinder compressor.

White-Superior *matched design* ENGINE-COMPRESSORS

White Diesel announces a line of medium speed, heavy duty, balanced opposed compressors, 200 to 1000 BHP, specifically engineered for combination with Superior natural gas engines. The complete, compact, *matched design* engine-compressor package provides continuous, heavy duty service for gas gathering, gas lifting, repressuring and booster applications.

Six inch stroke White compressors coupled to 9 inch and 10½ inch stroke Superior oil field gas engines provide optimum combinations of piston speed, horsepower and service life. Model W-62, two-cylinder compressor, ranges from 200 BHP with Superior 6G-510 gas engine to 635 BHP with 8G-825. Model W-64, four-cylinder compressor, is rated up to 1000 BHP with supercharged 8GX-825 gas engine. Standard cylinder sizes range from 4000 PSI, 2⅝″ dia. to 85 PSI, 22½″ dia., providing 68 different cylinders. Custom sizes and designs available.

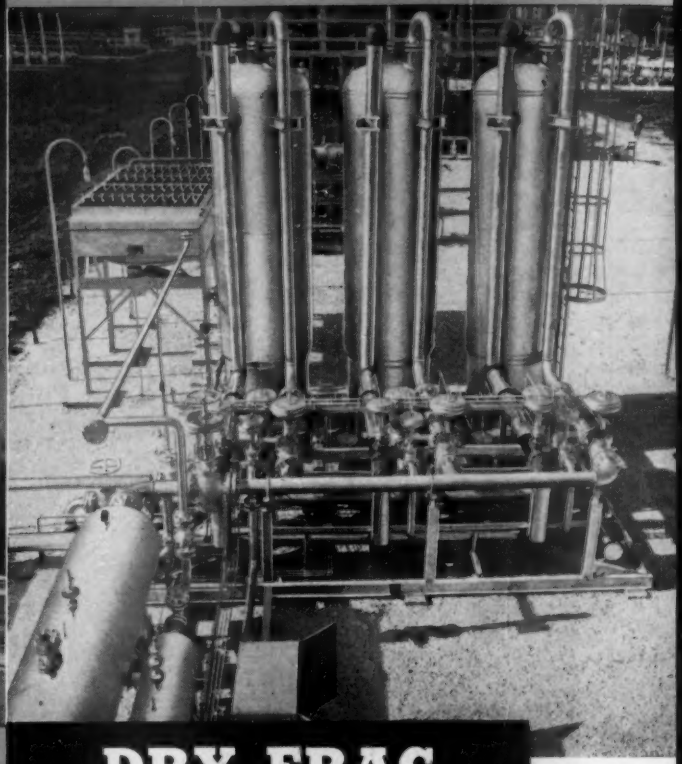
Speed of direct-connected engines (no belts or gears) can be varied from 600 to 900 RPM for easy control of compressor unit. Compressor cylinders can be easily changed on same frame to suit changing volume or pressure conditions.

Get new Bulletin 124 from White oil field representatives . . . or write today to:

Superior ENGINES | White DIESEL

White Diesel
WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY
Plant and General Offices: Springfield, Ohio

Rich Stream -- Lean Stream



COLD FRAC **DRY FRAC**

Different processes - one objective: PAYOUT!

Although the BS&B COLD FRAC and DRY FRAC processes and equipment are entirely different, both will dehydrate gas and recover hydrocarbon liquids while operating on an unattended basis. How, then, can you determine which process will give the best results for a specific application?

Generally, the COLD FRAC process is favored for use on a stream rich in C_5+ hydrocarbons. Variable design factors such as separation temperature, partial stripping of fluid, and balancing of the process to utilize equipment to its maximum capacity greatly affect the economics of this process, but it is not affected to any great degree by inlet temperature.

The DRY FRAC process is highly effective on streams with a low C_5+ GPM. Its efficiency is less affected than that of COLD FRAC by the composition of the wellstream, but it will recover a higher percentage of available pentanes from wellstreams of lean composition.

In addition to economic factors, there are other factors including flow rate, utilities, GPM, pressure and inlet temperature which should be taken into account before a selection of the process is made.

The important point to remember is that your BS&B Man offers a complete line of gas processing equipment, and is therefore in the best position to assist you in getting exactly the right equipment on your lease.

Ask your local representative for full information or write to Black, Sivalls & Bryson, Inc., Dept. 1-A3, P. O. Box 1714, Oklahoma City, Oklahoma.

BS&B

BLACK, SIVALLS & BRYSON

OKLAHOMA CITY • EDMONTON • LONDON • PARIS • THE HAGUE

LIGHT

exactly
where
you
need it...

Crouse-Hinds Explosion-Proof Lighting Fixtures in Class I, Group D location

Crouse-Hinds Vaportight Lighting Fixtures in a corrosive outdoor location

regardless of surrounding atmosphere!

When there's something in the air — explosive gases, ignitible dusts, corrosive fumes — Crouse-Hinds has exactly the light to give you lighting exactly where you need it — with complete safety!

Lighting that's safe to operate in explosive concentrations of acetylene . . . hydrogen . . . gasoline vapors . . . organic, inorganic or metallic dusts. Lighting that stands up under the corrosive attack of acids, salts, alkalis.

What *kind* of lighting do you need: Bench . . . area . . . flood? Incandescent . . . fluorescent . . . mercury vapor? Permanent . . . portable?

You'll find them all in the Crouse-Hinds catalog. It's the *only* place you'll find lighting for every Class and Group under the National Electrical Code.

Ask your Crouse-Hinds Distributor.

Crouse-Hinds Dust-Ignition-Proof Lighting Fixtures in grain elevator — a Class II, Group G location

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SYRACUSE NEW YORK

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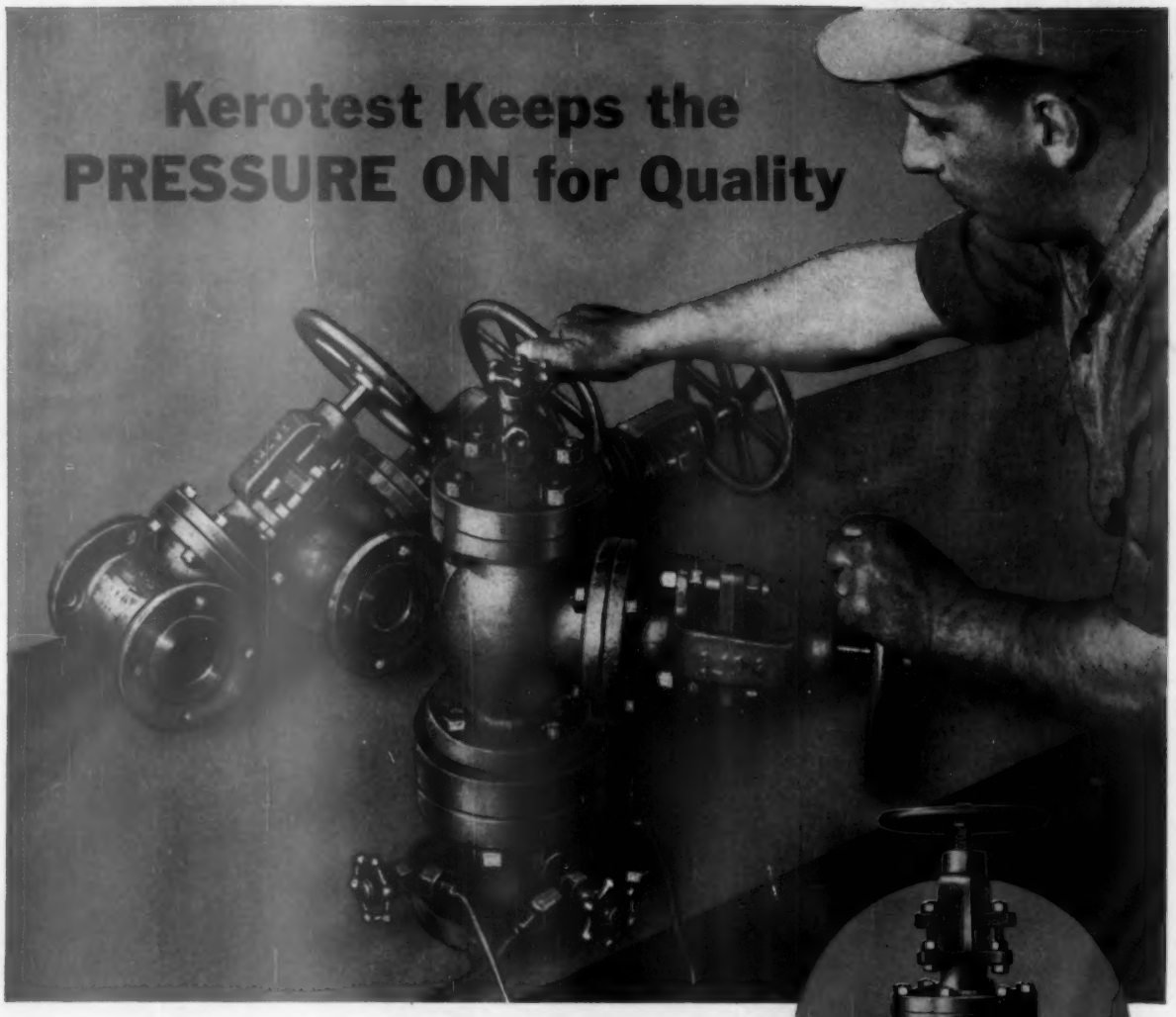
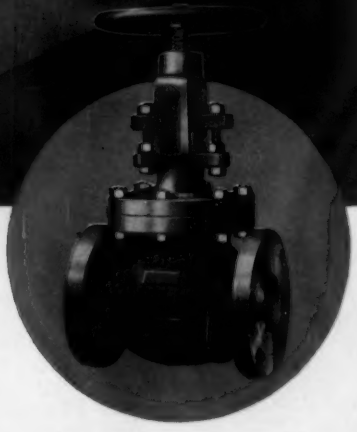
Kerotest Keeps the PRESSURE ON for Quality



Before any Kerotest cast steel globe valve goes on stream, it's tested and approved in this final three-phase hydrostatic test. Here, with valve open and flanges blanked, the shell is subjected to maximum specified water pressure. The valve disc is then closed and the seat seal is checked hydrostatically and by air.

This testing stand adjacent to the production line is but one of the many quality control procedures employed at Kerotest to insure soundness of castings, seat seals and other operating parts. What's more, Kerotest's advanced design features bring you more precise flow control and regulation, reduce maintenance to a new low and assure longer valve life in all types of applications.



KEROTEST
Quality Controlled Features

- Reinforced sections protect against unusual line strains, erosion and corrosion.
- Built for repacking under pressure in the full open position.
- Deep stuffing box for greater packing life and tighter seal.
- Threaded shoulder seating type seat rings replace without removing valve body from line.

There is a Kerotest Cast Steel Valve available for every class and condition of service.

Kerotest Cast Steel Globe Valves

High quality Kerotest cast steel globe valves are available in primary service pressure ratings ranging from Series 150 to Series 1500. They are supplied in various combinations of body and trim material for all types of service in oil, gas, steam, water, chemical, petro-chemical, marine and industrial installations.

Send for your free copy of the new, informative Kerotest booklet. It's packed with working tables, dimensions, specifications and other helpful information.

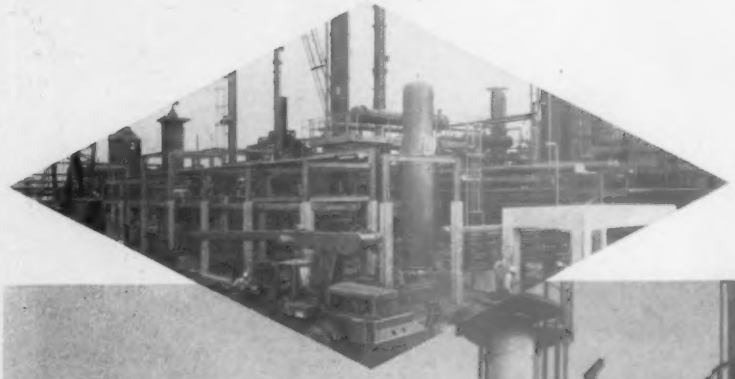
KEROTEST MANUFACTURING COMPANY

2582 LIBERTY AVENUE • PITTSBURGH 22, PA.

In Canada . . . Kerotest Cast Steel Valves are manufactured and distributed exclusively by Guelph Engineering Company, Guelph, Ontario, Canada

KEROTEST®

ON-SITE WITH PROCON



Procon-built Hydeal unit on-stream in 95 days!

Building a complicated process unit from the ground up requires the skillful coordination of a multitude of design, engineering, procurement and construction details.

It takes plenty of work, but most of all it takes time. Procon needed just 95 days from groundbreaking to on-stream acceptance of this Hydeal™ unit built for Signal Oil & Gas Company, in Houston, Texas. This highly efficient Hydeal unit produces 1,000 barrels-per-day of high quality benzene from a toluene charge. Signal markets the benzene direct to users in the Southwest.

New plant construction, expansion or modernization, whatever the requirement, you can trust the entire job . . . safely to PROCON.

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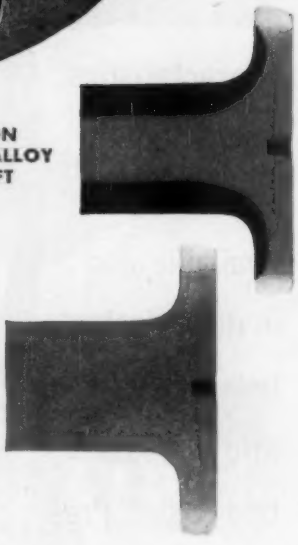
In New Trucks or Old—
EATON INDUCTALLOY AXLE SHAFTS

LAST 3 to 10 TIMES LONGER

Through billions of miles of heavy-duty service, Eaton Inductalloy Axle Shafts have proved their ability to deliver superior performance. Freedom from break-down—more time on the road, less time in the shop—plus thousands of trouble-free miles added to axle life, mean lower over-all operating cost.

Eaton's exclusive method of dual hardening truck axle shafts produces an extremely hard case extending deep into the material structure, and enables Inductalloy Axle Shafts to handle more work and abuse without fatigue failure.

Eaton Inductalloy Axle Shafts are available not only in new axle equipment, but also as replacements for earlier models. Ask your truck dealer for complete information.



EATON INDUCTALLOY SHAFT

ORDINARY AXLE SHAFT

EATON

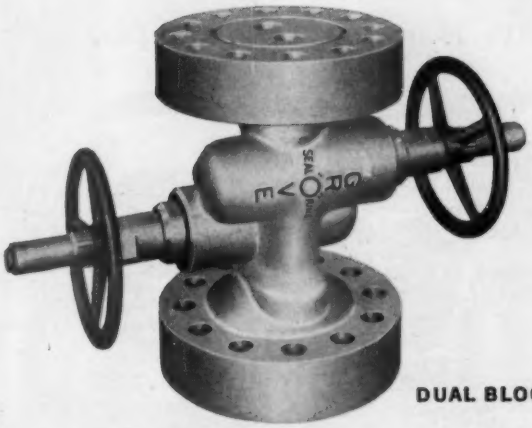
AXLE DIVISION

MANUFACTURING COMPANY

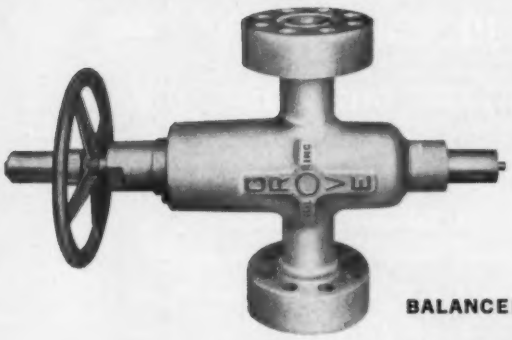
CLEVELAND, OHIO

Dependability is engineered into Grove G-2 production valves. Proved double sealing assures positive shut-off. Metal-to-metal seal is provided by the action of parallel sided gate (1) against precision ground metal inner seat rings. (2) Protected nitrile rubber o-rings (3) back up the metal-to-metal seal and keep the gate clean and smooth by squeegee action. Seal is positive on both sides of the gate. (4) No lubricants or sealing compounds are needed. Round, smooth, through conduit opening (5) assures ideal flow characteristics and freedom to pass tools. Available also in dual block, balanced stem and recessed body types. Pressures from 1,000 to 10,000 # w. o. g.

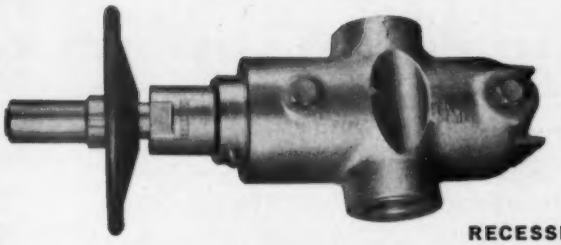
GROVE G-2 SEAL-"O"-RING GATE VALVES FOR PRODUCTION AND FLOW LINE SERVICE



DUAL BLOCK



BALANCED STEM



RECESSED BODY

GROVE PRODUCTION VALVES

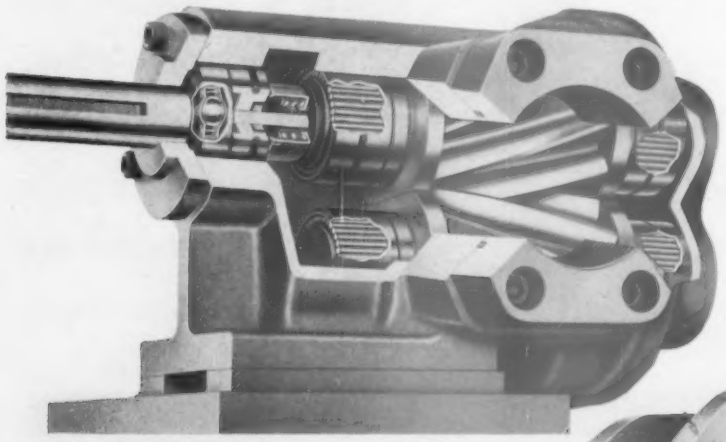
GROVE VALVE AND REGULATOR COMPANY

a subsidiary of Walworth

Oakland 8, California

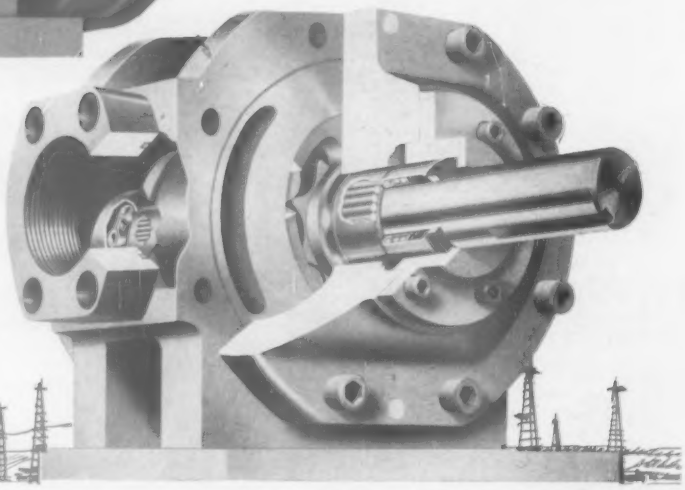
Offices throughout the U.S. and in Western Canada

Now from Brown & Sharpe,



New B&S Series 300, rotary-gear pumps are available for pressures to 300 psi; caps. of 40, 60, 90, 125, 175 gpm.

New B&S Series 700, gerotor-type pumps for pressures to 1000 psi; caps. of 20, 30, 40, 60, 80 gpm. (Note: This highly-efficient pump has unusually long life. Contact between its inner and outer elements progresses at only 1/9 driven speed.)



a brand new line of Rotary Pumps with 5 big advantages to cut maintenance costs

1 Standard bolts and screws are used throughout. If lost, they're quickly and easily replaced.

2 Simple, rugged construction. Pumps are easy to take care of because they're easy to understand.

3 Choice of threaded or plain pipe flanges, both easily replaced.

4 Roller bearings give you longer service from pumps before any maintenance is required.

5 Replaceable wear plates are easily changed — give new life to the pumps, after normal wear.

Reduced maintenance cost is just one of the reasons why you appreciate these new pumps. You save on installation and get longer life, too.

Brown & Sharpe Series 300 and Series 700 Pumps are designed specifically for the Petroleum Industry, to save you money right down the line.

Start saving now! Contact your local oil field supply store about new B&S Pumps. Ask them for a catalog, or write: Hydraulics Div., Brown & Sharpe Mfg. Co., Providence 1, Rhode Island.

Brown & Sharpe PRECISION CENTER

Oil company reports PERFORMANCE PLUS with Sumitomo steel tubing

A leading drilling company in Texas reports that Sumitomo tubing far exceeded API specifications when run as drill string, despite 46 rugged round trips in and out of a 5700-ft. well under 1200-lb. mud pressure.

Performance like this shows why Sumitomo steel pipe and tubing, produced in accordance with API, ASTM and many other international standards, are exported in all sizes and grades to every major part of the world.

Available in API Standards in the following sizes:

Casing 4½" to 13⅜" O. D.
Tubing 1.660" to 4½" O. D.
Line Pipe 0.840" to 14.00" O. D.
High Test Line Pipe 6⅝" to 14.00" O. D.

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UNION PIPE, INC.

(AGENT OF OIL COUNTRY TUBULAR GOODS IN U.S.A.)
420 LEXINGTON AVENUE, NEW YORK 17, N.Y.

7 years of constant use...

and Davison Silica Gel still meets required dew point

In tower after tower, operation after operation, millions of cubic feet of natural gas are being dried in beds of Davison Silica Gel that were installed two, three and even seven years ago. In one large South Central gas treatment installation, Davison Silica Gel was still effectively removing moisture and maintaining satisfactory dew point after 29,690 consecutive hours on stream.

Davison Silica Gel's proven long-lived efficiency is one of the reasons it is being selected to replace other desiccants in increasing numbers of gas drying and hydrocarborn recovery installations. The higher purity of Davison Silica Gel reduces the possibility of carbon build-up in the desiccant pores. Higher purity, coupled with its larger surface area and granular form, has proven Davison Silica Gel to be an ideal desiccant.

For complete information on the advantages and profit-building potential of Davison Silica Gel for natural gas drying, write Dept. 3103.

GRACE

DAVISON CHEMICAL

Industrial Chemicals Dept. 3103, Baltimore 3, Md.

JUST LIKE MONEY IN THE BANK

Save as you store volatile liquids in General American conservation structures

General American fabricates tanks with every type of floating roof, tanks with lifter roofs, dry-seal gasholders and vapor balancers that will pay for themselves with the product they save.

Two outstanding seals—the Wiggins Safety Seal, safest, surest seal you can buy, and EverSeal, a solid cushion seal especially made for "problem" liquids — are offered with the floating roofs.

Skilled field crews of General American and subsidiaries are available to erect these structures where you require them.

Write for General American Bulletin No. PW-1059 for descriptive details.

General American Floating Roofs
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Double Deck
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General American Floating Roof Seals
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Other conservation structures
Lifter Roof Tanks
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ANOTHER BEAIRD FIRST

A completely packaged 10,000,000 cf/d gasoline plant

Antelope Gas Products' Harry P. McClintock (Managing Partner) won out over severe Nebraska weather and an isolated location with his plan for a factory assembled gasoline plant.

Eleven miles north of Kimball, Nebraska is a revolutionary new 10,000,000 cf/d gasoline plant (capability 75,000 gallons liquid products) whose speed and economy of installation and fabrication may set a new trend in design. Conceived by Harry P. McClintock, Managing Partner of Antelope Gas Products, the prefabricated plant overcame the handicaps of a location with severe winters, limited construction weather and a shortage of skilled local labor.

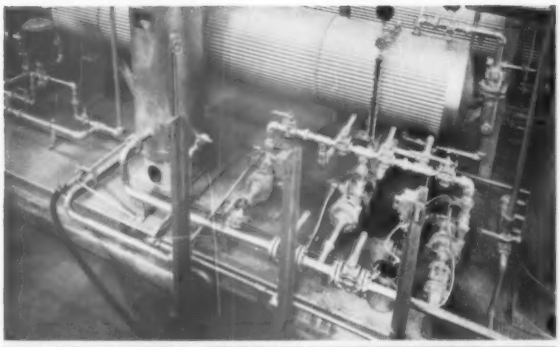
A major breakthrough in unified engineering between process designers and fabricators, the plant went on stream in less than three and a half months from the day of ground breaking. This amazing record was achieved by having the complete facility factory assembled, tested, skid mounted and shipped to location ready to go on stream with only interconnecting piping and outside of the building items left for final assembly at the job site.

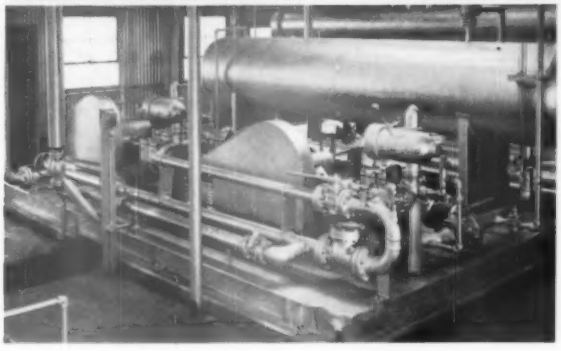
Process engineering and field installation was performed by O. L. Olsen Company, Inc., with the J. B. Beaird Company, Inc., serving as the single source of responsibility for engineering assembly, purchasing and fabrication of pressure vessels and packaged plant components.

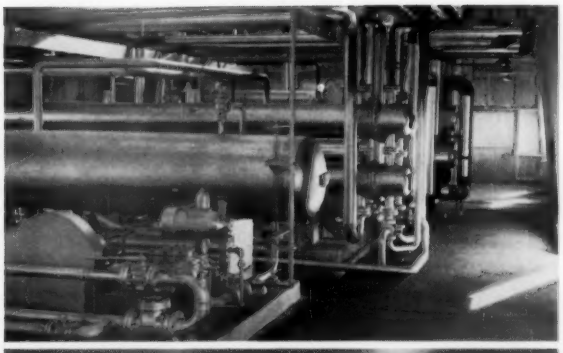
The entire operation is built around eleven skid mounted units. Three of these are 660 horsepower Beaird-Ingersoll-Rand packaged compressors, with eight skids handling the entire gas processing system. Each skid unit serves multiple process functions which were grouped by Beaird engineers for economy and convenience of interconnecting piping and fabrication.

Packaging of the plant effected major savings for Antelope Gas Products. Much of the normally costly field labor and installation time was eliminated. A simplified building and foundation met all requirements. Hauling and shipping costs were lowered. And should the plant be moved at some future date . . . everything except the foundation can be salvaged.

When your next gasoline plant is still in the planning stage . . . let a qualified Beaird engineer show you the savings possible through factory assembly and packaging of the process functions. *Contact your nearest Beaird representative or write direct.*



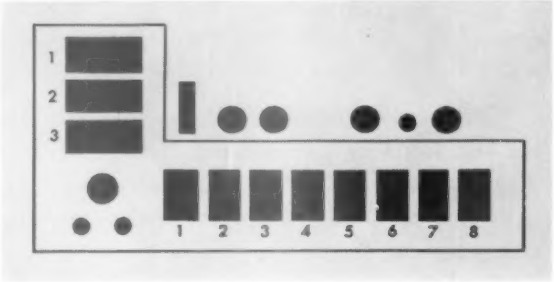




EACH SKID UNIT HANDLES MULTIPLE PROCESS FUNCTIONS

1 Grouping of components on skids was determined by convenience and economy of piping as well as related process function. Skid 2 contains depropanizer and debutanizer relux accumulators and their pumps. Not shown, but overhead on the skid, are the condensers. Other units include a stripping steam generator and a depropanizer reboiler.

2 Lean oil pumps, surge tank and pulsation dampeners are mounted on skid 5.



PACKAGING SIMPLIFIED PLANT LAYOUT

3 From the center of the Process building, skids five through eight can be seen. Packaging of the units made possible the clean schematic layout of the entire plant. Interconnecting piping and product lines are located overhead, leaving an uncluttered walkway around all sides of the units. This arrangement promotes safety, simplifies maintenance and encourages good housekeeping.

SINGLE RESPONSIBILITY REDUCED PLANT COSTS

4 Beaird handled complete purchasing, fabrication and engineering assembly of all pressure vessels and skidded plant components. 270,000 gallons of storage and four towers were included in the thirty-three pressure vessels fabricated by Beaird. Unified engineering and purchasing effected substantial savings for Antelope Gas Products.

BUILDING BLOCK PLANT LAYOUT

Economical installation and simplified construction of the plant building were made possible by packaging of the process units. Skids one thru three are 660 horsepower Beaird-Ingersoll-Rand Packaged Compressor Plants. Skids four thru eleven handle all process functions. Four Towers, an oil reclaimer and a process oil tank are located in the ell formed by the compressor and process buildings.

another AMF BEAIRD product

THE J. B. BEAIRD COMPANY, INC.

A subsidiary of American Machine & Foundry Company

SHREVEPORT, LOUISIANA

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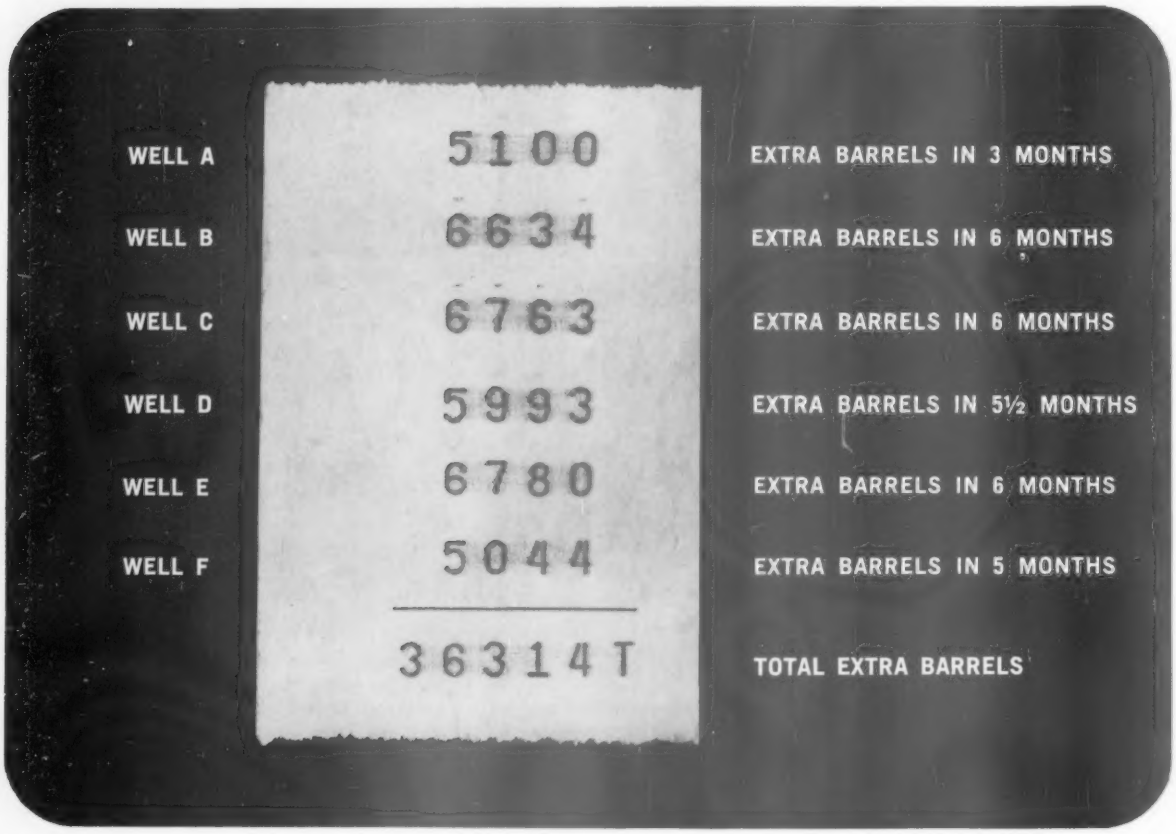
BEAIRD INTERNATIONAL, INC., SHREVEPORT, LOUISIANA

could you use production increases like these?



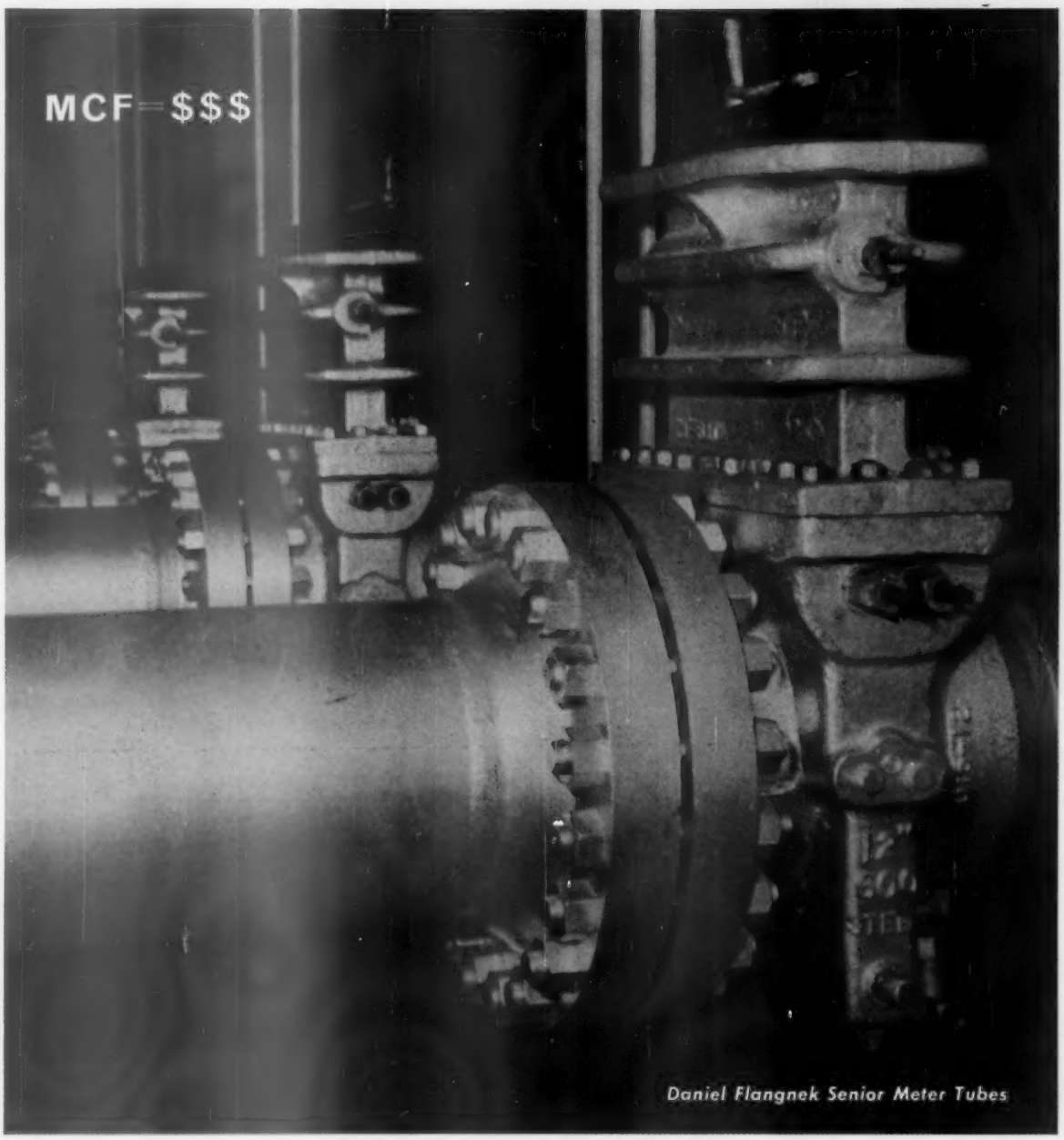
This operator got 36,314 barrels of extra oil from six wells within six months after they were fractured by Dowell. Total service costs for the six treatments averaged only $2931.79 per well. The extra oil produced during the first six months, as a result of fracturing, cost less than 49 cents per barrel. Additional production after the first six months will be almost clear profit.

All six wells, in Manitoba, Canada, were treated by Dowell at about the same time. All were given similar treatments in which 50,000 pounds of 20-40 mesh sand, at 2-3 pounds per gallon of lease oil, were injected into the pay zone at about 40 bpm. The production gain was determined for each well by comparing total production for equal periods immediately before and after treatment. Production periods were six months for three of the wells. Records for the other three wells covered 5½, 5 and 3 months, both before and after treatment.

Your production problem may be different from the one faced by this operator. The chances are good, however, that Dowell engineers can design a treating program to help you produce more oil at less cost per barrel.

For service or more information . . . call Dowell. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

SERVICES FOR THE OIL INDUSTRY **DOWELL** DIVISION OF THE DOW CHEMICAL COMPANY



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Natural gas changes hands in a hurry at the orifice meter station. Here is where millions of cubic feet become dollar signs. You expect optimum "cash register" accuracy and performance. You know you'll get just that with Daniel Orifice Fittings and Meter Tubes because they have the closest tolerances and are easiest to operate. Fast delivery, too. In all sizes (2"–36") and pressure ratings (125 lbs.-2500 lbs. ASA), you can depend on Daniel.

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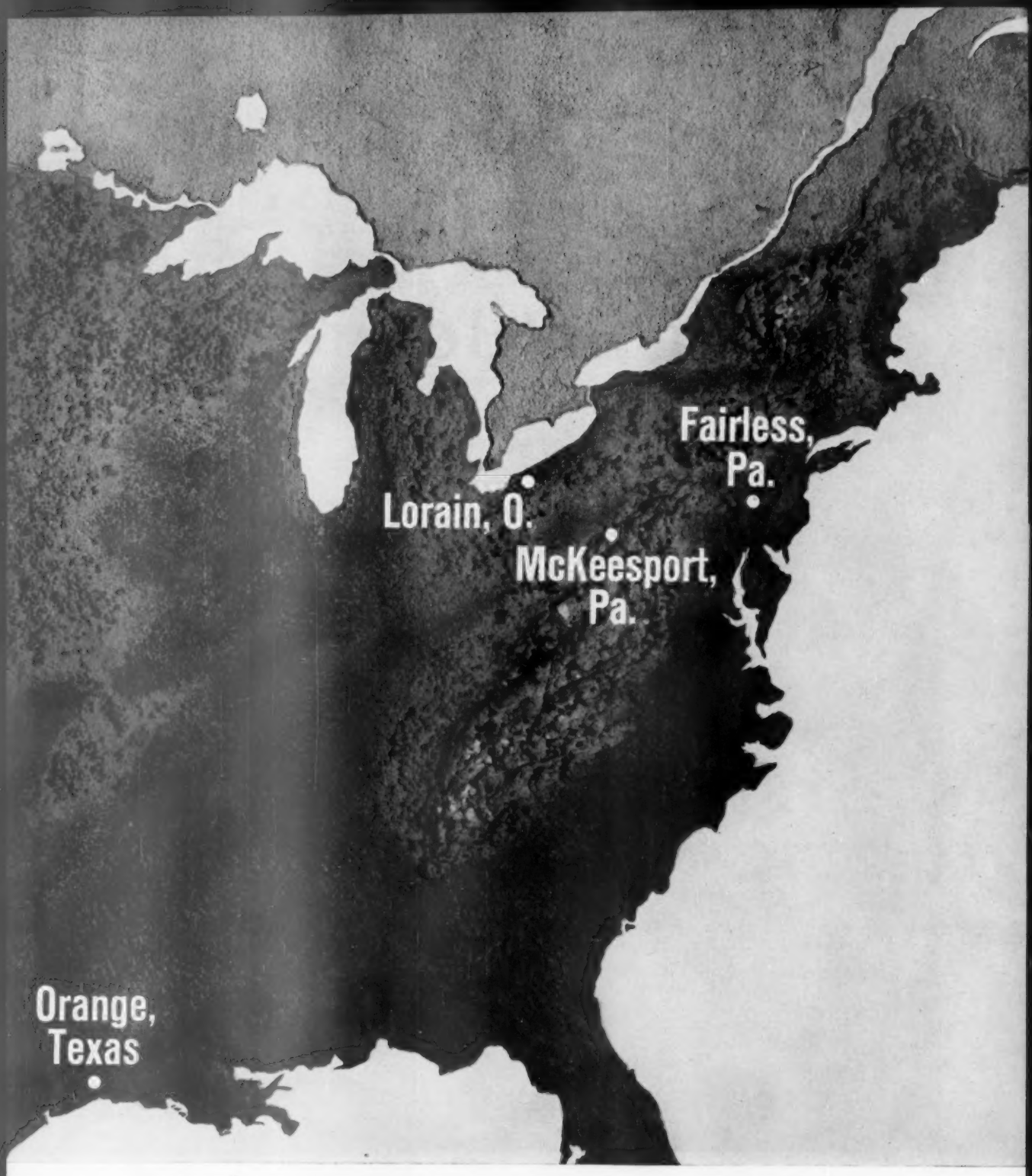
Only USS National Line Pipe is made in so many places... and so well



Convenient to you—a complete range of grades and sizes of QUALITY line pipe, no matter where you are. These five pipe mill locations will give you excellent service.

*Consolidated Western Steel Division of United States Steel.

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National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Export Company, New York

This mark tells you a product is made of modern, **dependable** Steel

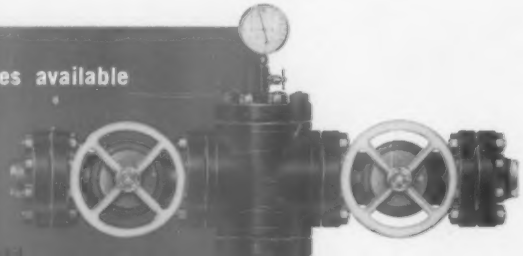
Only USS National Line Pipe is made in so many places... and so well

O·C·T can solve your storage well-head problems

OCT engineering has provided effective solutions to the problems of equipping LPG and natural gas storage wells for several years. This wide experience goes to work for you with every OCT Christmas tree you install.

Here are some of the OCT well-head features available to solve storage problems:

- a full range of well-head equipment to handle any need



Convenient to you—a complete range of grades and sizes of QUALITY line pipe, no matter where you are. These five pipe mill locations will give you excellent service.

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This mark tells you a product is made of modern, dependable Steel

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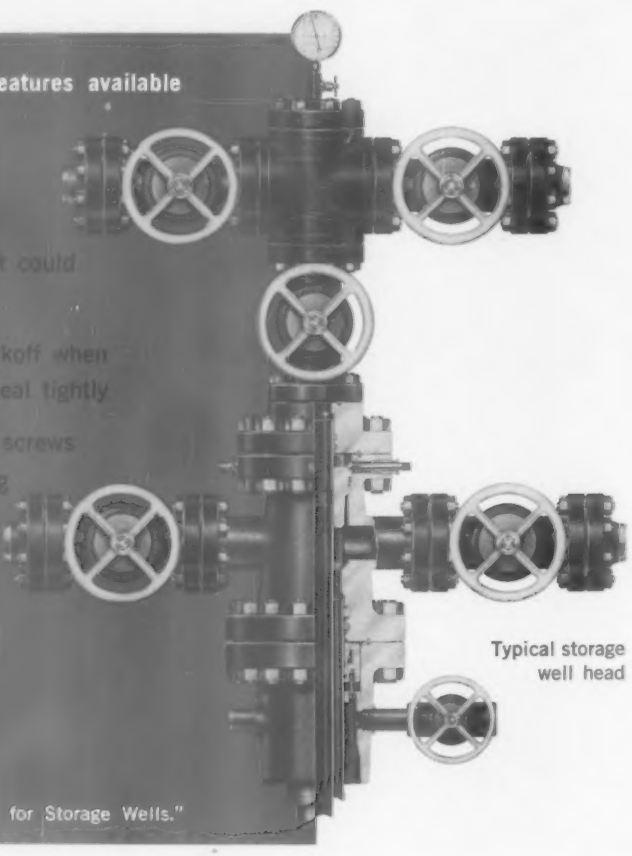
OCT engineering has provided effective solutions to the problems of equipping LPG and natural gas storage wells for several years. This wide experience goes to work for you with every OCT Christmas tree you install.

Here are some of the OCT well-head features available to solve storage problems:

- a full range of well-head equipment to handle any need
- flanged connections to stop leakage that could occur at screwed connections
- lockdown screws to provide positive packoff when shallow casing strings are too light to seal tightly
- threaded casing hangers with lockdown screws to prevent vibration from loosening casing and allowing it to fall
- strippers to permit casing movement during cavern-washing operations
- the large well-head equipment needed to meet typical storage-well needs



Typical storage well head

Write for our booklet "O-C-T Well-Head Equipment for Storage Wells."

where progress is a daily practice

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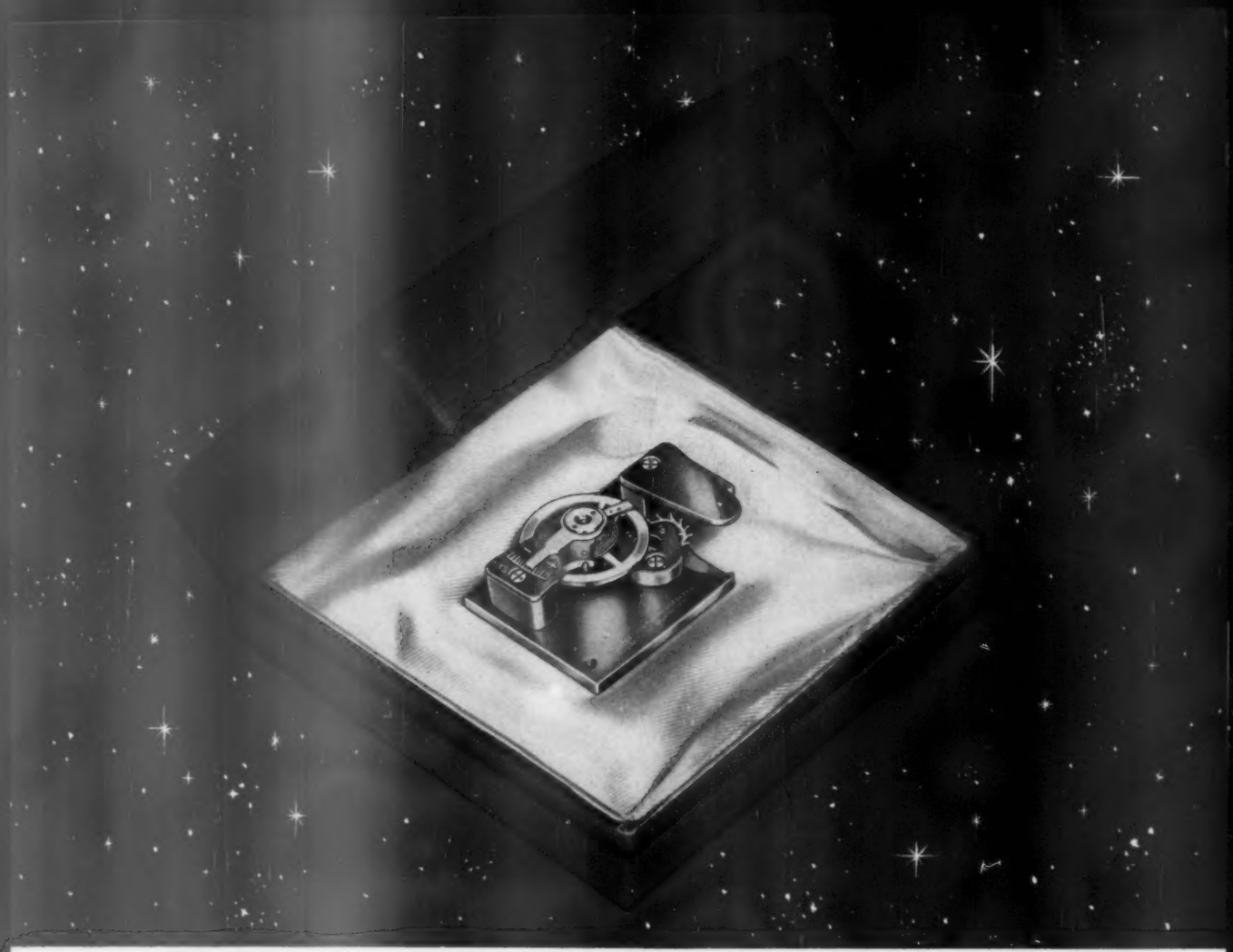


This "jeweled" escapement brings you fine watch quality in chart drives

See how easy it is to convert to seven different rotation rates

The main arbor on the basic chart drive has a rotation rate of seven days. Economical snap on turrets convert this rate to 8 day, 15 day, 16 day, 24 day, 30 day, 31 day and 24 hour rotation. No tools are required and you can even change chart rotation without removing the drive from the instrument.

Now, for the first time you get the extra value of a jeweled movement. This superior construction makes Rockwell chart drives more accurate and sensitive than ordinary chart drives. It requires less power to drive and is extremely durable since there are seven hard jeweled surfaces to overcome friction and wear.

You can use these jeweled movement chart drives *with profit* to power all your recording instruments. They will adapt into practically any instrument case. Speed changing turrets (see left) permit varying rotation rates at will. Write for bulletin. Rockwell Manufacturing Company, Dept. 59C, Pittsburgh 8, Pa. In Canada, Rockwell Manufacturing Company of Canada, Ltd., P.O. Box 420, Guelph, Ontario.

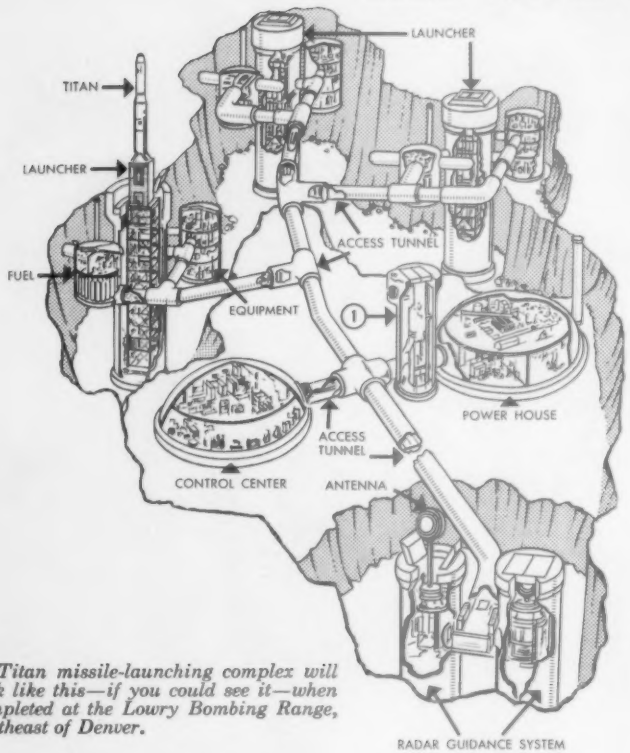
JEWELED CHART DRIVES

another fine product by

ROCKWELL

PUMPAGE

Goulds news about pumps for process industries



A Titan missile-launching complex will look like this—if you could see it—when completed at the Lowry Bombing Range, southeast of Denver.

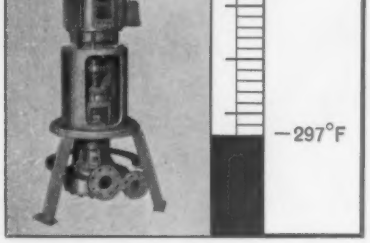
Goulds ductile iron pumps help build TITAN MISSILE MUSCLE

Deep under the Colorado earth, two gigantic Titan missile bases are taking shape. Powerhouse and control center are vast domed structures. Three two-story structures will store fuel. Four-story cylinders will house monitoring and other operating equipment.

Immense and complex, the bases require a wide variety of pumping services. Goulds, the major pump supplier, is building hundreds of units —from vertical sump pumps to high-temperature, high-pressure units.

Many of the pumps *must* be able to stand severe shock so we are making these, or their critical parts, of ductile iron. Castings range from ½ lb. to over 1800 lbs., making up probably the largest order for ductile iron pumps ever placed.

If you'd like to know why ductile iron has unusual resistance to stress, impact, and high pressures, send for Bulletin 765.7.

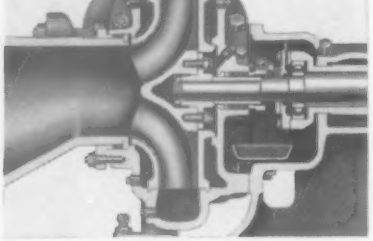


How to pump cryogens

One company pumps liquid oxygen at −297°F with this process pump.

Model 3181's basic design especially fits it for low-temperature pumping. Casing arrangement of suction limits pressure on column, bearings and seal to vessel pressure only. Special magnetic mechanical seal seals shaft.

Cryogens raise special problems in selecting pump design, materials, and seal. Our engineers, experienced in these applications, can help you. Write us.



Cotton pickin' pump

Nine Model 3135s pump cotton linter stock *in a smooth flow* for Southern Chemical Cotton Co.

The fine cotton fibers can't clog the open end suction impeller. Ejector vanes on back wall of impeller follow curvature of main vanes, prevent entrance and jamming of stock between wall and stationary sideplate. There is no impeller nut or other obstruction at the impeller eye to catch fibers.

For specifications and performance data, send for Bulletin 723.1.

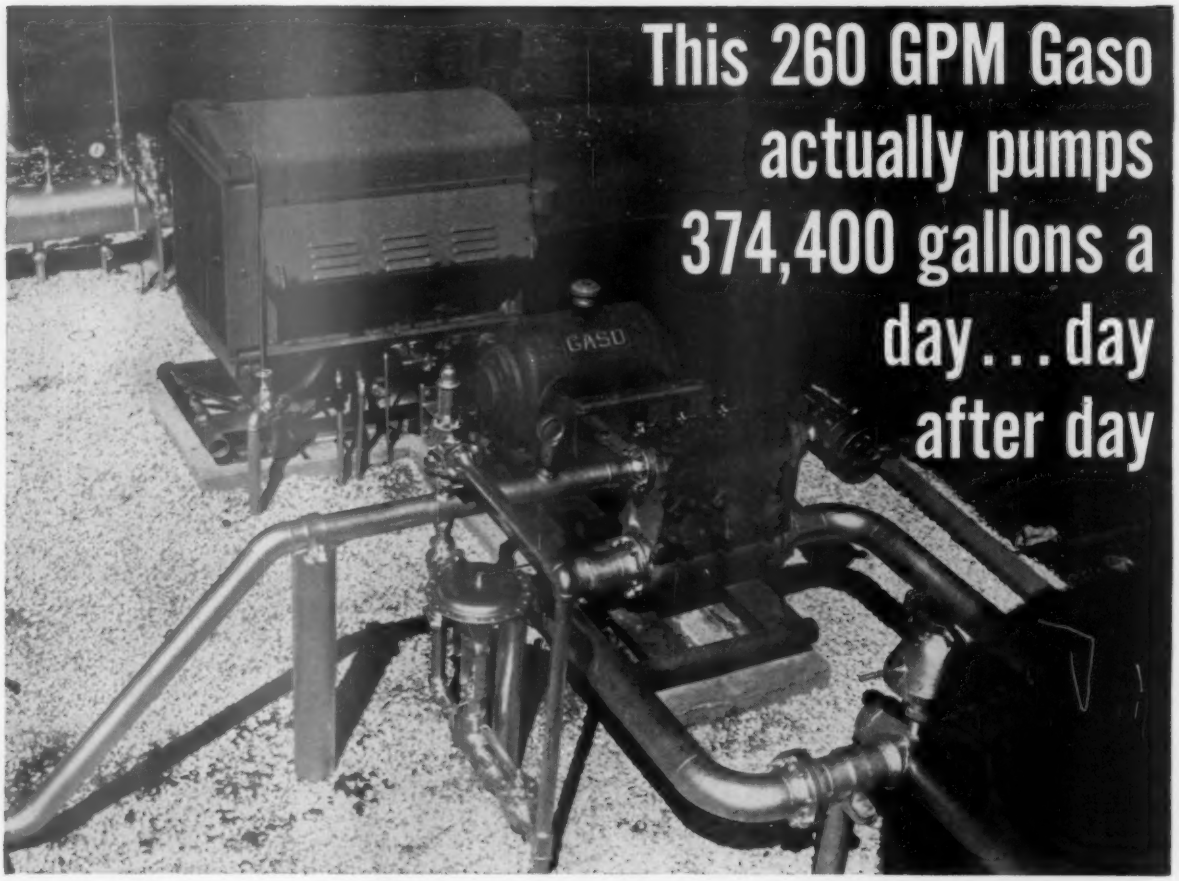
Now... small-capacity pump for chemicals and slurries

Handles up to 115 gpm of corrosive chemicals, thick or abrasive slurries at heads to 150 ft.

Of single-stage side-suction open-impeller design, Model 3199 has hydraulically balanced impellers with ejector vanes on back wall to keep out solid material and reduce stuffing-box pressure. Bearings are isolated in cooling chamber.

For specs, ratings and other data, write for Bulletin 720.5. Goulds Pumps, Inc., Dept. OGJ-31, Seneca Falls, New York.

GOULDS PUMPS

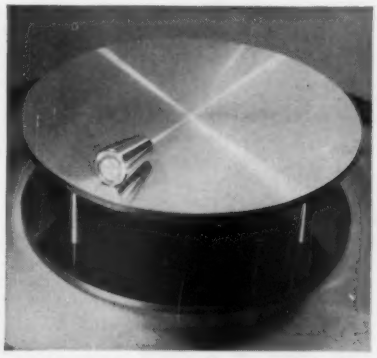


This 260 GPM Gaso actually pumps 374,400 gallons a day... day after day

When Gaso tells a prospect that this Gaso 3600 series triplex pump is good for 260 gallons a minute, it's more than a specification. It's a promise that it will keep at it, day after day, with a minimum of maintenance. To be sure they make good on their promise, Gaso engineers specified double-row Timken® tapered roller bearings for the main crankshaft.

Each row of rollers in a Timken *tapered* roller bearing share exactly half the pure radial load in these pumps. Full bearing capacity is thus assured as the crankshaft rotates at up to 350 RPM, pumping crudes, gasoline, propane, acids, or water at pressures from 800 to 3750 psi and from 48 to 260 GPM. Along with their extra load-carrying capacity, Timken bearings permit a larger diameter crankshaft, increasing rigidity and reliability.

SERVICE from the experts is yours for the asking when you use Timken bearings. Graduate engineer salesmen work fast—right at your drawing board to help you get the most bearing capacity for your dollars.



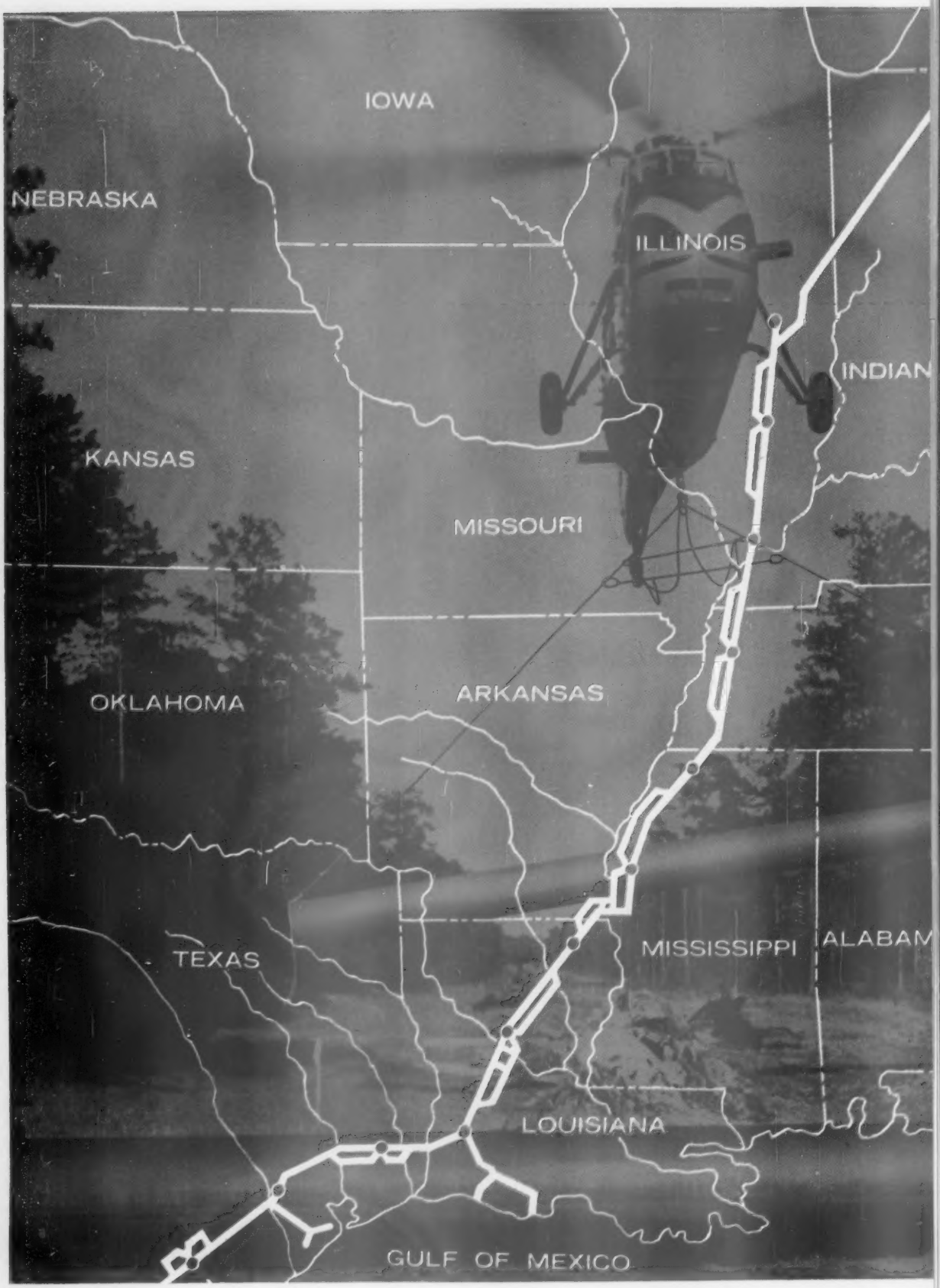
ROLLS FOREVER in the same circle. This oscillating table demonstrates the accuracy of the taper of a Timken bearing roller. Precision manufacture assures you each bearing part carries its share of the load.

Industry rolls on

TIMKEN®

tapered roller bearings

The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Division: Canadian Timken, St. Thomas, Ontario.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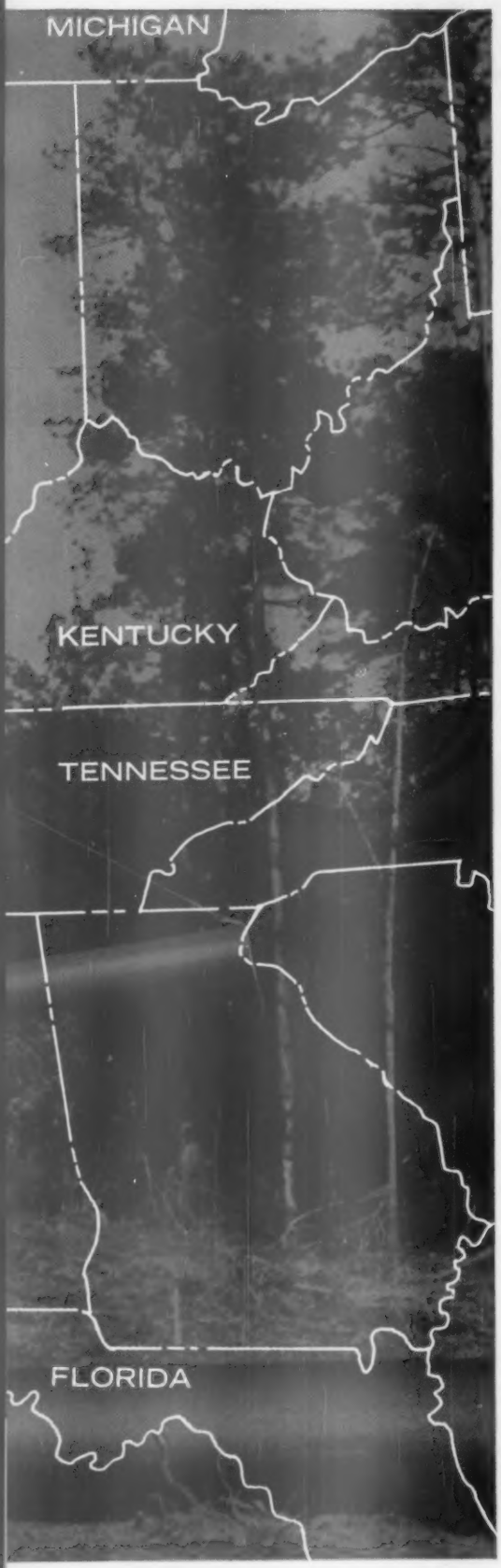

TRUNKLINE GAS COMPANY

strings pipe from the sky

"Pipe Lift" helps tie loops between Texas and Illinois... swells line by 135,000,000 cubic feet of natural gas per day

Linking the gas fields of Texas and Louisiana to Consumers Power Company of Michigan was the objective of Trunkline Gas Company's new pipeline project.

Besides main-line loop, the project also consisted of gathering lines in Texas and Louisiana and a main-line extension through Illinois and Indiana. Work began in August of 1959. Although progress was impeded by the steel strike, marshy terrain and a severe winter, the system was completed by June of 1960. Pipe stringing by helicopter was Trunkline's unique way of speeding up operations through some relatively inaccessible areas during the worst part of the winter weather.

A. O. SMITH supplied approximately 193 miles of 24-inch through 30-inch pipe for this important line.

FOR OVER 30 YEARS . . . A. O. Smith line pipe has always been manufactured to the highest standards of quality . . . precisely controlled at every step of production. That's why A. O. Smith pipe made and installed way back in 1928 is still in operation. That's why so much of it is found in every major pipeline project.

Through research ...a better way

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CORPORATION

TUBULAR PRODUCTS DIVISION
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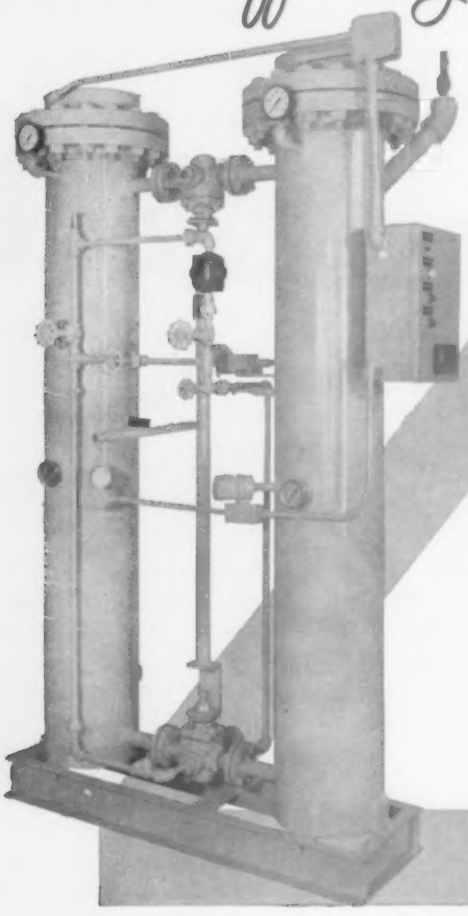
KEMP ORIAD DESICCANT DRYERS

cut costs, add efficiency 4 ways!



1 Complete reactivation

An exclusive 3-zone embedded heater design gives every Kemp Oriad Desiccant Dryer extra drying power *economically* (effective distribution of heating elements assures high heat transfer efficiency). The most complete reactivation results... providing maximum desiccant capacity, minimum dewpoint performance.

2 Full automatic operation

Set the program timer and everything is regulated automatically. Gases are dried with the least pressure loss, lowest maintenance and operating costs. Your choice of manual or semi-automatic systems, too.

3 Accurate temperature control

Thermostatic control conserves heat input... maintains ideal temperatures for highest operating efficiency in drying instrument air, process air and gases to the lowest dew point, eliminating condensation or freeze-up, and other applications.

4 No moving parts

There are no blowers, fans or motors to create maintenance problems, rising operating costs. Unit comes fully assembled, ready to go. Liquid dryers also available. Write today for Bulletin D-103, or contact your Kemp man, listed in the Chemical Engineering Catalog.

It always pays to come to

KEMP OF BALTIMORE

THE C. M. KEMP MANUFACTURING COMPANY
405 E. Oliver St., Baltimore 2, Md.

This mark tells you a product is made of modern, dependable Steel.

Is your sucker rod problem fatigue? Then get tough! Tough steel, that is.

The one outstanding, reasonably priced steel—with *Toughness* to take fatigue—is Boron Alloy steel. But this steel should be *liquid quenched and tempered* for optimum results.

"Oilwell" has exclusive liquid quench—hot straightening equipment. After extensive field tests using this steel in sucker rods, we found it to have remarkable fatigue-resistance under heavy loads. It also performed well under hydrogen embrittlement conditions.

This *Toughness* is offered in the NEW "Oilwell" GRADE "O" SUCKER ROD—complete with the needed liquid quench and temper—priced just above the carbon steel normalized rods.

Try *TOUGHNESS* in your next well. We welcome "alternate rod" tests of Grade "O" against any rod in its low price class—call your nearby "Oilwell" Store. *USS and "Oilwell" are registered trademarks*

Oil Well Supply Division of United States Steel

USS

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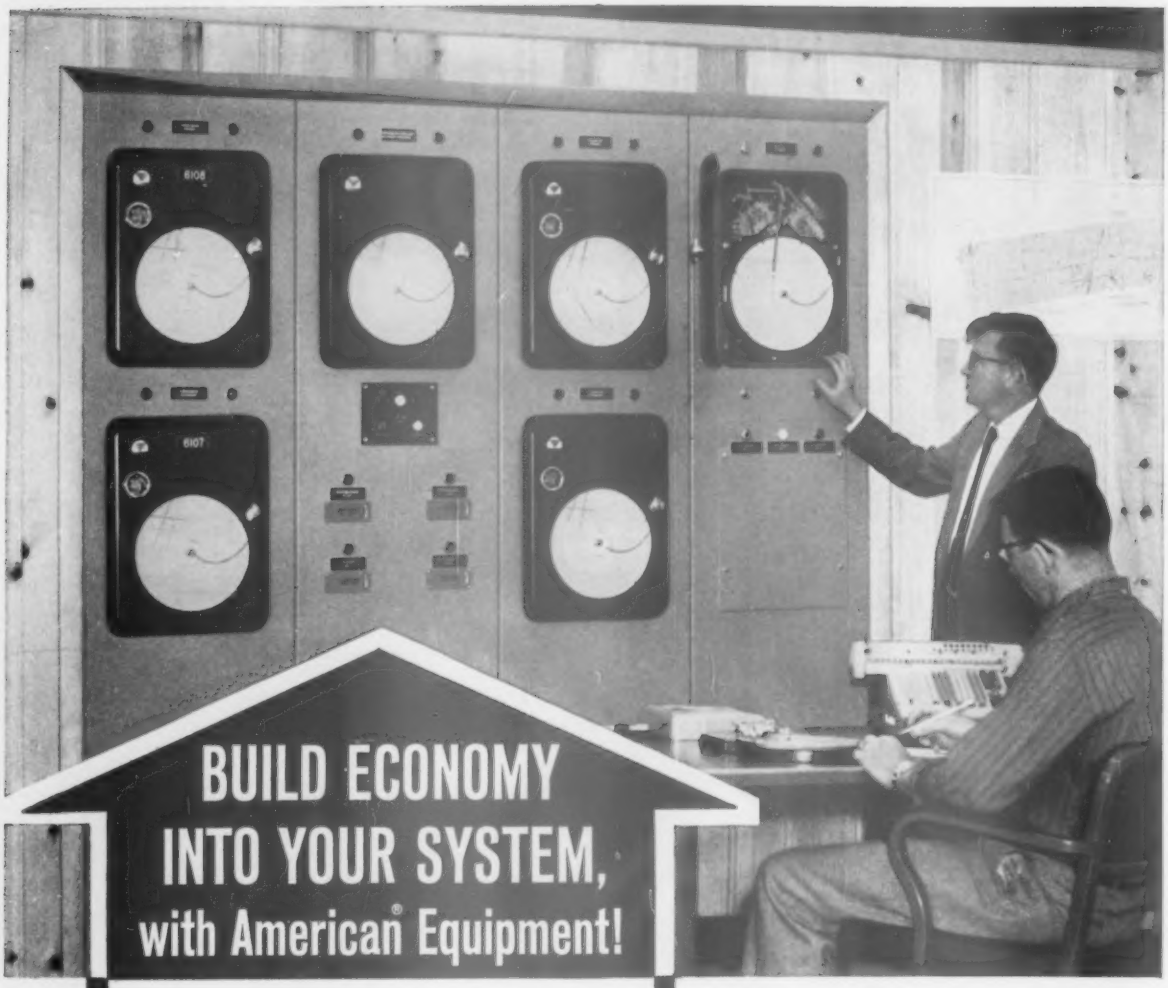

BUILD ECONOMY INTO YOUR SYSTEM, with American® Equipment!

If you're already using American measurement and control equipment on your system — large or small — you know how it reduces manpower requirements and provides continuous operating economies. If you're not already saving with American equipment, ask your representative for full information. You'll be surprised to learn how little it costs to build sustained accuracy, dependability and long-term operating economies into your system.

TELEMETERING SYSTEMS — Designed to meet the individual requirements of any system.

CONTROLLERS — Series A-88 Controllers, Transmitters and Receivers for measurement and control of continuous process variables.

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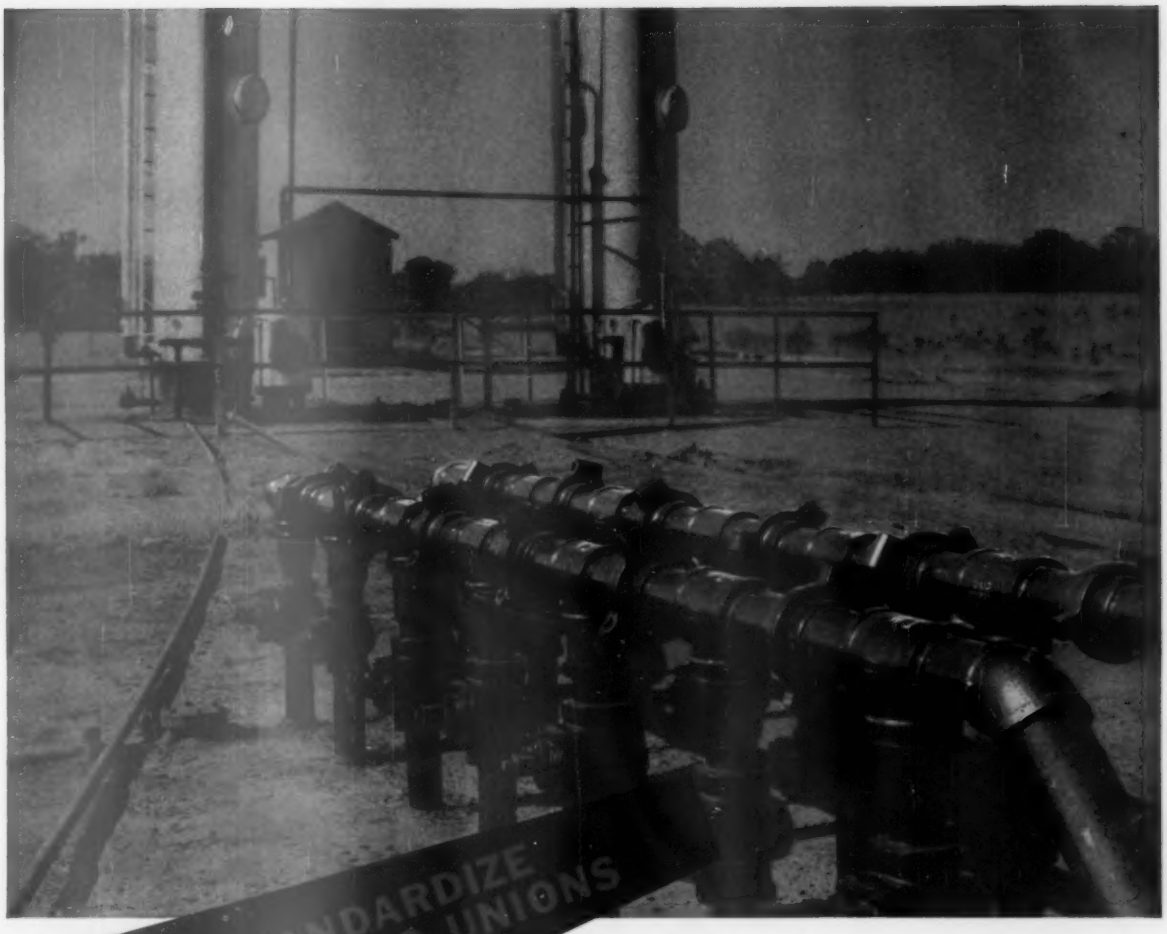
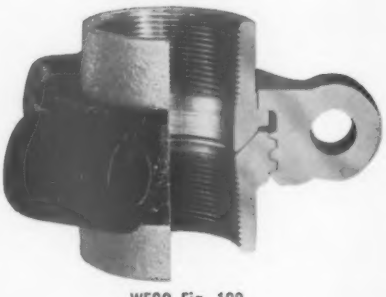


the key to streamlined, economical production hook-ups

When laying field lines, setting tank batteries, separators, heaters, treaters, etc.—when assembling headers and manifolds, WECO Unions are your best, most dependable, leakproof connections. The ball and cone seat seals leakproof with just a few turns of the wing nut. The precision-cut pipe threads on the subs fit perfectly, run up fast and leakproof without galling or damage.

When valves, meters, regulators and other control equipment are installed with WECO Unions, they can be removed with the minimum of time and effort. In fact, any production unit can be removed easily from the line for repairs or maintenance when you Standardize with WECO Unions in your production hook-ups.

Next time and every time, specify WECO Unions, and you will soon have your standardization program complete, saving you time and money for years ahead. Talk to your WECO Representative or your Supply Store for WECO UNIONS.



WECO Fig. 100
1000 psi test
Sizes: 2" thru 8"

This popular 3 lug "Bar Nut" union is ideal for production installations. Completely interchangeable.

WECO WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS
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WECO UNIONS

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HAMER LINE BLIND VALVES

HAMER PLUG VALVES

WECO AIR-O-UNION

WECO COMPOUNDS

WECO SNATCH BLOCKS

Looping through Coosa – and Tallapoosa, too

As many Alabamans know, Coosa and Tallapoosa counties are on the route of Transcontinental Gas Pipe Line Corporation's Brownsville-to-New York City trunk main.

And right at the border of the two counties is where our photographer "shot" the 36-in.-OD Bethlehem Line Pipe you see here.

The Sharman, Allen, Gay & Taylor spread is one of a number of main-line loops in Transco's current program, which totals over 200 miles of line in Louisiana, Mississippi, Alabama, Georgia, and South Carolina.

Bethlehem supplied 36-in. pipe (.406 and .469 in. walls) for installation in all those states. It was epoxy-lined at our Steelton, Pa., pipe mill.

LINE PIPE TO 42 IN.—Big as the Transco pipe is, it isn't the largest made by Bethlehem. We can produce it to 42 in. OD—and with ¾-in. walls! It's electric fusion-welded, and hydraulically expanded.

ERW PIPE TO 16 IN.—At Sparrows Point, Md., we produce electric resistance-weld pipe from 5⁹⁄₁₆ in. through 16 in. OD, and in lengths to 62 ft. We also produce continuous buttweld pipe from ½ in. through 4½ in. OD. Of course, all sizes of Bethlehem line pipe conform strictly to appropriate API 5L or 5LX specifications.

Want more information? Just call the Bethlehem sales office nearest you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
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for Strength
. . . Economy
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BETHLEHEM STEEL

CONTACTOR NUMBER 6

AMINE PROCESS DESIGN AND OPERATING INFORMATION

Proper use of amines in well designed, correctly operated equipment is essential for efficient gas treating. Some of these important design and operating considerations will be discussed in this series.

Foaming Difficulties in Treating Systems

Foaming difficulties are frequently encountered in the operation of gas treating units employing Ethanolamines and Ethylene Glycols. The mere production of some foam is not necessarily a sign of trouble. But if the foam generated is too stable, you can expect difficulties in operating gas treating columns.

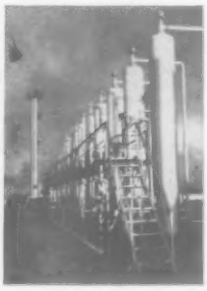
Analyzing Foaming Characteristics

The foaming characteristics of a solution may be determined qualitatively by using a medium or fine fritted glass dispersion tube to bubble air through a sample of the plant solution in a graduated cylinder. You should have a means of measuring air flow so that reproducible rates can be used. Use two or three air flow rates – e.g., .03, .05 and .10 cu. ft./min. for a 50 ml sample. Make observations at room temperature and at about 50°C (122°F) for the following:

1. Type of foam formed (bubble size, apparent consistency).

2. Time required for foam to reach maximum height.

3. Time required for foam to break after air flow is stopped.



Evaluate these observations by running the same test on equivalent amine or glycol solutions made up from fresh, unused amine or glycol.

Common Foam Stabilizers

Excessive foaming is usually caused by small amounts of stabilizers. Known offenders are:

- Field corrosion inhibitors carried into the units from the field.
- Plug valve greases which contain soap bases.
- Napthenic acids and higher molecular weight organic acids which are present in certain petroleum streams.
- Suspended solids.
- Hydrocarbons dispersed in the solution.

Proper Care Best Cure

The best cure for foaming problems is proper care of the amine or glycol solution. In amine systems, first preventive steps are proper reclaimer operation and adequate filtration–using activated charcoal, in some cases, to adsorb foam-generating materials. In glycol systems, first steps are proper pH control, adequate filtration and provision for good separation of hydrocarbons and glycols.

If foam inhibitors are needed, it should be remembered that these do not solve the basic problem, but merely provide control until the cause can be determined and remedies effected.

Effect of Additive on Foam

The effect an additive has on foaming properties of a system frequently depends on when it is added. Hence, some materials–if added after foam is generated–act as foam inhibitors, but–if added prior to foam generation –act as foam stabilizers. This is important in evaluating foam suppressants.

Evaluating Foam Inhibitors

Foam inhibitors should be evaluated on a laboratory scale by adding them to a sample prior to running the foam test described above. Since the effectiveness of a defoamer depends on the chemical nature of the materials causing the foam, each unit has to be evaluated individually with various inhibitors.

Of compounds with defoaming properties, oleyl alcohol has been widely used in amine systems as a defoamer. It is also effective in glycols. However, in glycol systems, it is more effective in combinations with C_{10}-C_{12} alcohols. These alcohols work best against non-ionic foaming agents.

Silicones are effective against certain ionic foamers such as sulfonated petroleum oils. Combinations of silicones, too, in some cases, suppress foam better than one alone.

In testing foam inhibitors, look for ease of dispersion. This will give you a clue to a defoamer's duration of activity since inhibitors which are difficult to disperse may be readily lost from the system.

FOR MORE INFORMATION look for future issues of Allied Chemical Contactor featuring articles on Ethanolamines and Glycols in gas treating operations.

We will gladly send technical data, delivery and price information on Allied Chemical Ethanolamines and Ethylene Glycols.

For specifications and local offices, see our insert in Chemical Materials Catalog, page 272 and in Chemical Week Buyers Guide, page 27A.

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2819

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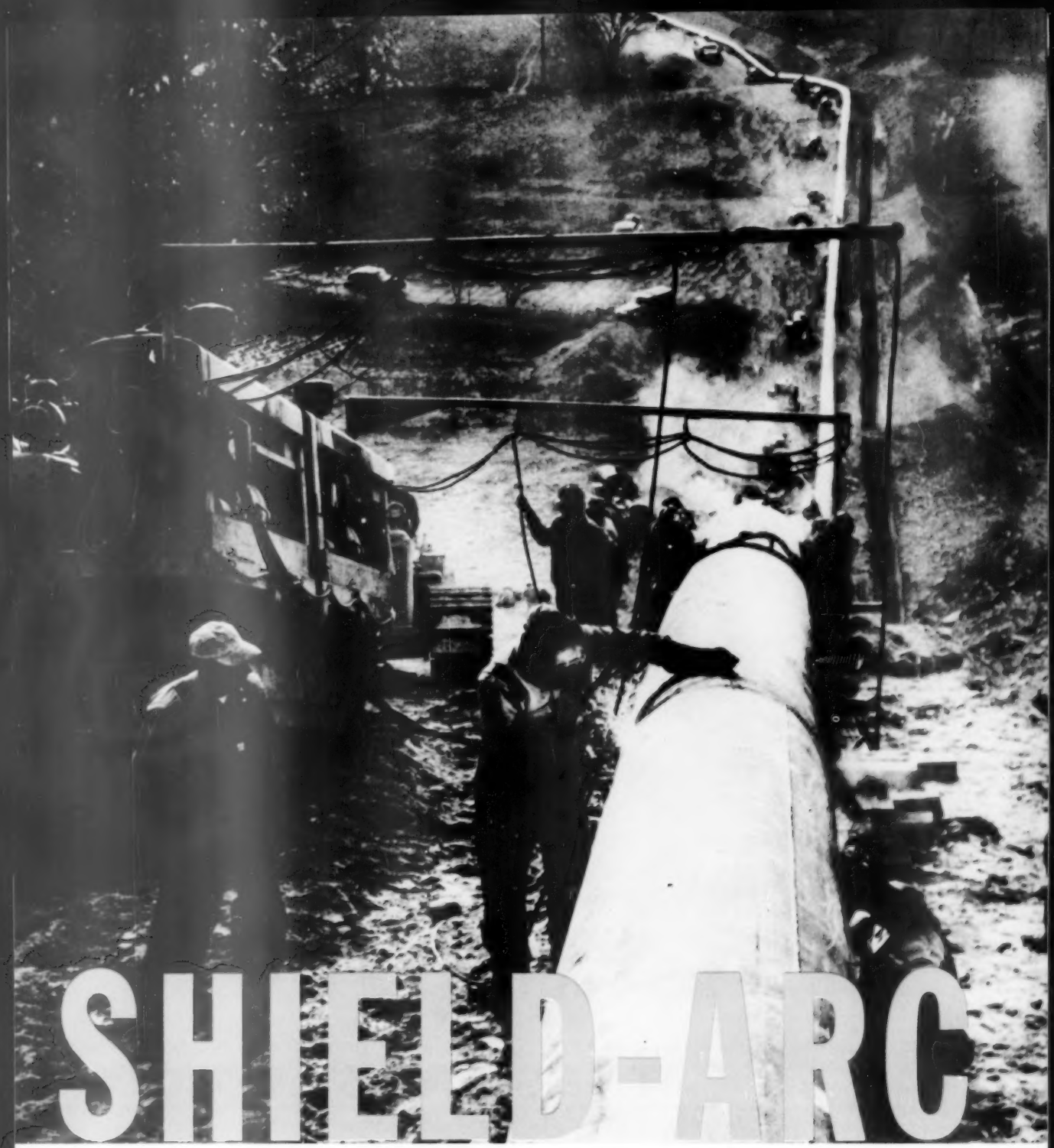
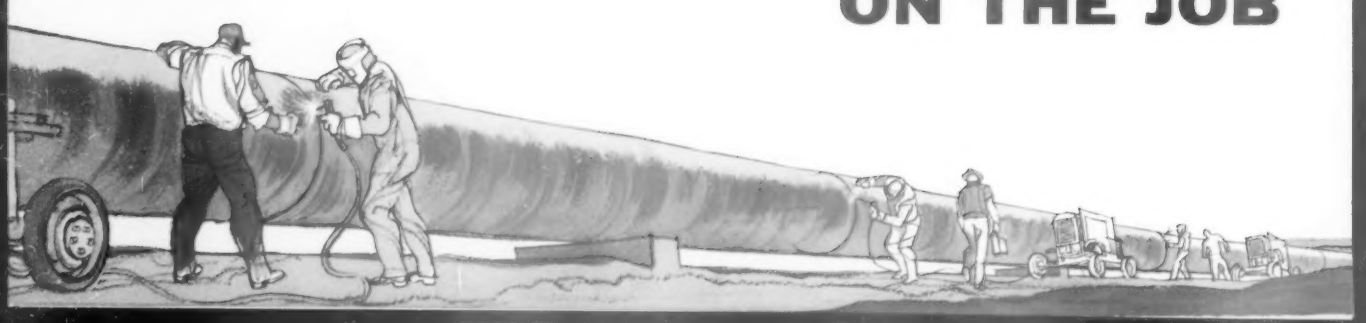


Stretch. Crane your neck. Squint. As far as you can see pipe—you'll see Lincoln Shield-Arc engine welders laying down metal. Why so many Lincolns? Because this contractor—after trying other makes—proved for himself that Shield-Arcs are unquestionably the best for day-in, day-out durability, operator appeal, reliability, low cost. The next few pages show why.

All-welded harbor warehouse in Long Beach, California, made architectural history as one of the largest, open-span buildings ever constructed. Contractor used Lincoln SA-200 welders which operate at low engine speed, require little maintenance, assure utmost reliability. The Lincoln SA-200 is by far the most popular gas engine welder ever built.

Even Louisiana swamps can't bog down these welding workhorses. Right this minute Lincoln machines are at work all over the world in the toughest imaginable field conditions—in jungles, Arctic ice packs, deserts. They're there on pipelines, refinery and building construction jobs because each part, from engine to brush holder to box-section frame, is built to give an extra margin of service, even when going is toughest.

THESE ARE LINCOLN SHIELD-ARCS ON THE JOB



Lincoln Shield-Arcs perform as well high in the Colorado mountains as they do at sea level thanks to the generous surplus power delivered by oversized engines. This reserve power means full generator output, no power drop-off even from older machines which have seen years of service. You get consistently excellent performance, low-cost maintenance, longest life with Lincoln Shield-Arc engine welders.

All construction welding is easy and trouble-free when you use Lincolns. They keep costs down, profits up. Weldors know, like and do their best with Lincoln machines. Dual Continuous Controls let operator select exact machine settings he knows will do the job best—whether flat, vertical or overhead. Idling device and design efficiency keep fuel costs low.

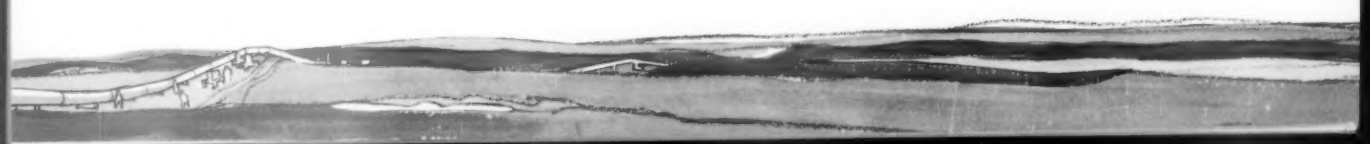
Chicago Bridge & Iron Company operates 685 engine-driven welders . . . 660 of them are Lincolns. Williams Brothers Company has 161 Shield-Arcs . . . all are Lincolns. Bechtel Corporation has 353 machines . . . 351 are Lincolns. And Pittsburgh-Des Moines Steel Co. has 53 at Neville Island . . . all Lincolns. There are many good reasons why these companies and others rely so heavily on Shield-Arcs.

Lincoln has a full line of gas or diesel machines . . . one for any job. Each is powered by a thoroughly proved-in-service Hercules, Continental or General Motors engine that will keep on running long after other equipment has given out. Idling device drops engine speeds to low idle to conserve fuel when not actually welding, automatically picks it up to operating speed when the arc is struck.

Each is equipped with Dual Continuous Controls which let a weldor select both welding heat and arc characteristics to suit his own technique. Once set, Lincoln Shield-Arcs hold their output indefinitely, won't drop off after extended use. This means better results on such critical work as stringer beads. Rugged, lightweight box-section bases on all Lincoln engine welders can stand the gaff when the going gets roughest.

Why don't you get this kind of rugged dependability and sure-fire welding performance? Put Lincoln Shield-Arc engine-driven welders on your construction jobs. Get all the facts from your local Lincoln Field Engineer . . . a specialist in welding.

LINCOLN
WELDERS



SA-200 Most Popular 200-Ampere Engine Welder Ever Built

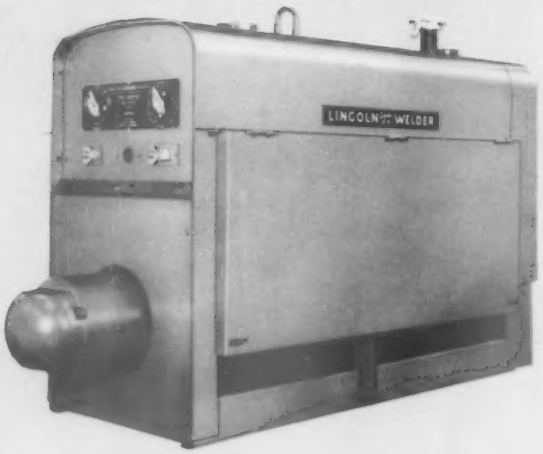
MODEL	SA-200
Current Rating (NEMA) at 40 volts	200 amps
Duty Cycle	60%
Current Range	40 to 300
Engine	Continental
Horsepower	36 @ 1450 rpm

SAE 300, 400 and 600 Machines Deliver Full-Range of Welding Currents

MODEL	SAE-300	SAE-400	SAE-600
Current Rating (NEMA) at 40 volts	300 amps	400 amps	600 amps
Duty Cycle	60%	60%	60%
Rated Current Range (amps)	60-450	80-600	120-750
Engine, 6-cylinder	choice: Hercules or Continental	Hercules	Hercules
Horsepower	47 @ 1400 rpm	63 @ 1400 rpm	82 @ 1400 rpm

Need Diesels? Pick from SAE 250, 300 and 400 Diesel Engine Welders

MODEL	SAE-250	SAE-300	SAE-400
Current Rating (NEMA) at 40 volts	250 amps	300 amps	400 amps
Duty Cycle	60%	60%	60%
Rated Current Range (amps)	50-325	60-450	80-600
Engine	Continental	GM	GM
Horsepower	35 @ 1700 rpm	35 @ 1675 rpm	50 @ 1625 rpm



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The World's Largest Manufacturer of Arc Welding Equipment and Electrodes

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Our loyal readers, and the advertisers from whom they buy billions of dollars worth of equipment annually, have again combined to put The Journal in the top spot.

The Oil and Gas Journal's 1960 advertising volume was more than the total of the next three petroleum industry publications.

We are justly proud of this record, and we thank our readers and advertisers alike for their confidence which has made this twelve-year record possible.

A very large portion of these 6,400 advertising pages are "exclusive" in The Oil and Gas Journal, because our customers have long ago learned that the effective, economical way to reach buyers in the petroleum industry is to concentrate the bulk of their advertising and do a dominant job in the leading publication FIRST

Source: Industrial Marketing and Advertising Age

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FOR YOUR WETTEST JOBS

Wagner® Silicone Rubber Insulated Motors

Power-packed drip-proof polyphase motors that are exceptionally moisture-resistant . . . save you money in lower initial equipment cost for many applications

These are motors that are built to take on and tame the toughest jobs. Big, job-rated motors, available in frames larger than 445U, through 1000 horsepower. Perfect drives that can be used for station auxiliaries, in chemical plants, in rubber and paper mills and in the petroleum industry.

With motor coils completely sealed in a jacket of silicone rubber and housed in a compact, drip-proof enclosure, these Wagner® motors are suitable for use in highly humid atmospheres. They perform perfectly even after long exposure, and at elevated temperatures. Since moisture does not penetrate their tough silicone jackets, they are now used for many installations that once required totally-enclosed motors. Silicone rubber insulated motors cost less to buy than equivalent totally-enclosed fan cooled motors, since there is no need for expensive enclosures.

But your savings don't stop with initial cost. When rated to match normal load, Wagner silicone rubber insulated motors deliver rated horsepower at top efficiency. They have more overload capacity for temporary overloads . . . reduce downtime while they help keep production levels up.

Like to hear the whole money-saving story of these dependable Wagner silicone rubber insulated motors? Call your Wagner Sales Engineer . . . then settle back for some profitable listening.

Wagner Electric Corporation

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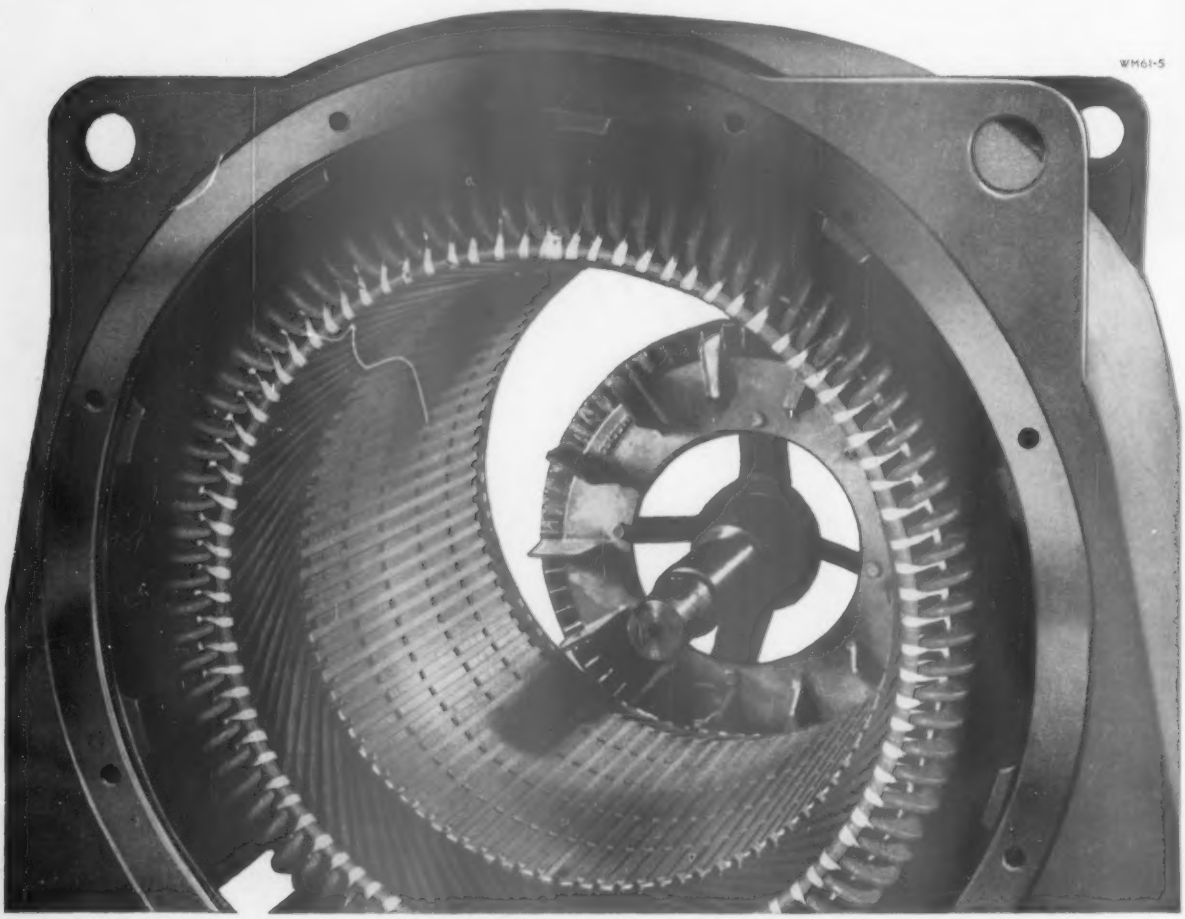

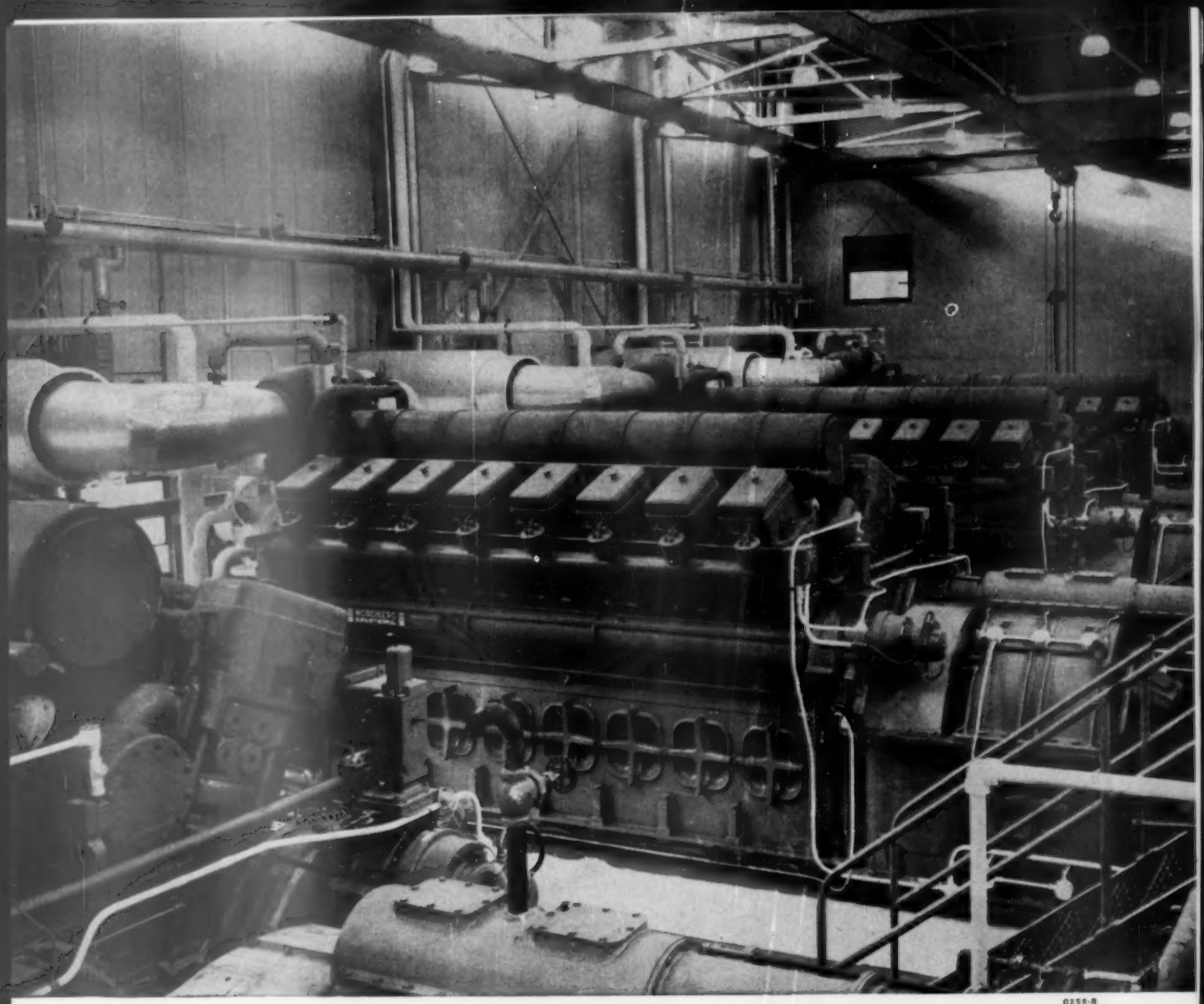

0259-B

Pipe line engines by Nordberg

Eleven Nordberg *Supairthermal*® spark-ignition gas engines are presently in operation at the second, third and last station along the new Westcoast Transmission Company Ltd. 30″ gas pipe line in western Canada. Each of these units consists of a 16-cylinder Nordberg V-type engine, rated 3550 bhp at 500 rpm driving a 24″ x 24″ centrifugal gas compressor thru a built-in, 10:1 speed increasing gear.

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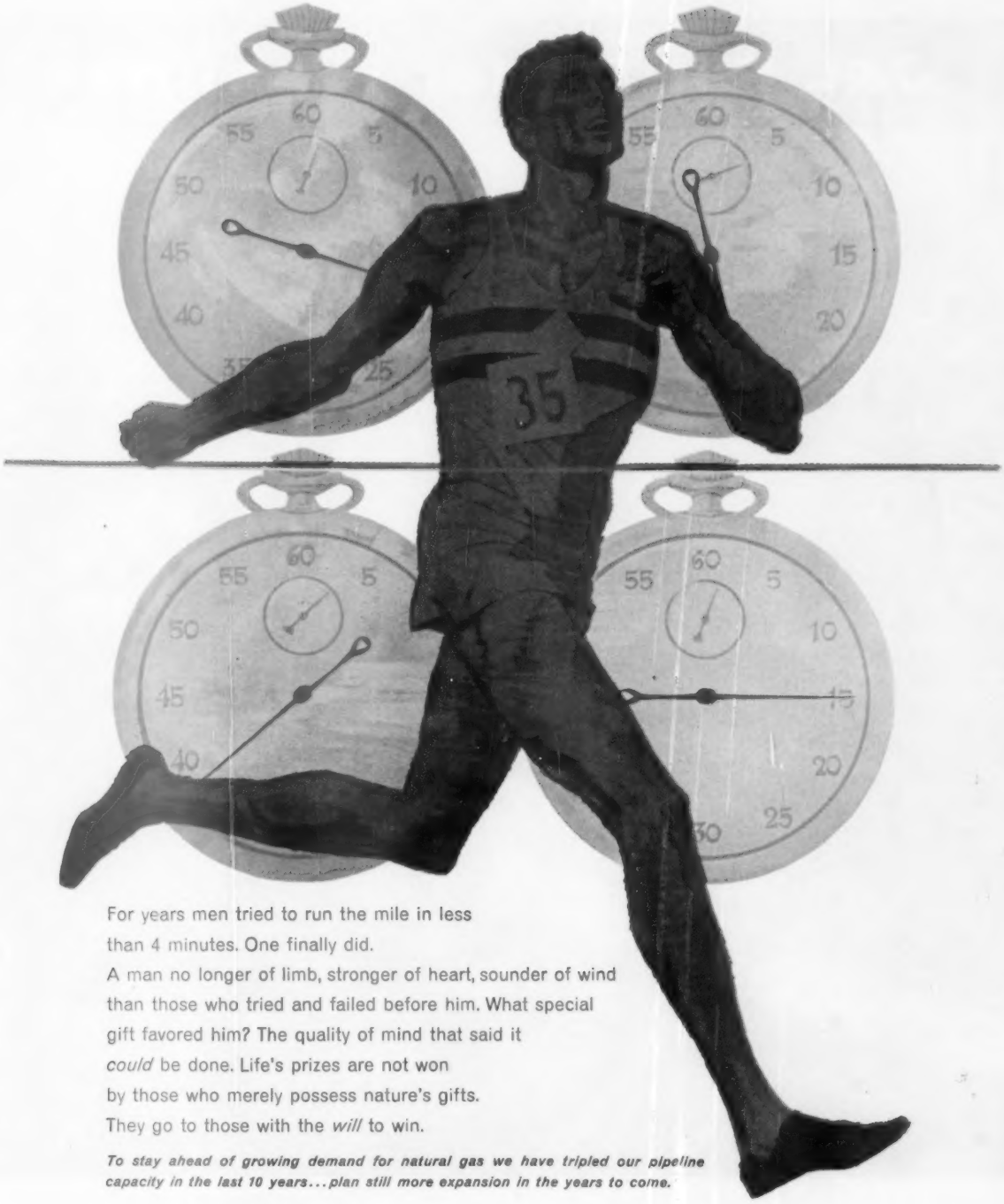

For years men tried to run the mile in less
than 4 minutes. One finally did.
A man no longer of limb, stronger of heart, sounder of wind
than those who tried and failed before him. What special
gift favored him? The quality of mind that said it
could be done. Life's prizes are not won
by those who merely possess nature's gifts.
They go to those with the *will* to win.

To stay ahead of growing demand for natural gas we have tripled our pipeline capacity in the last 10 years... plan still more expansion in the years to come.

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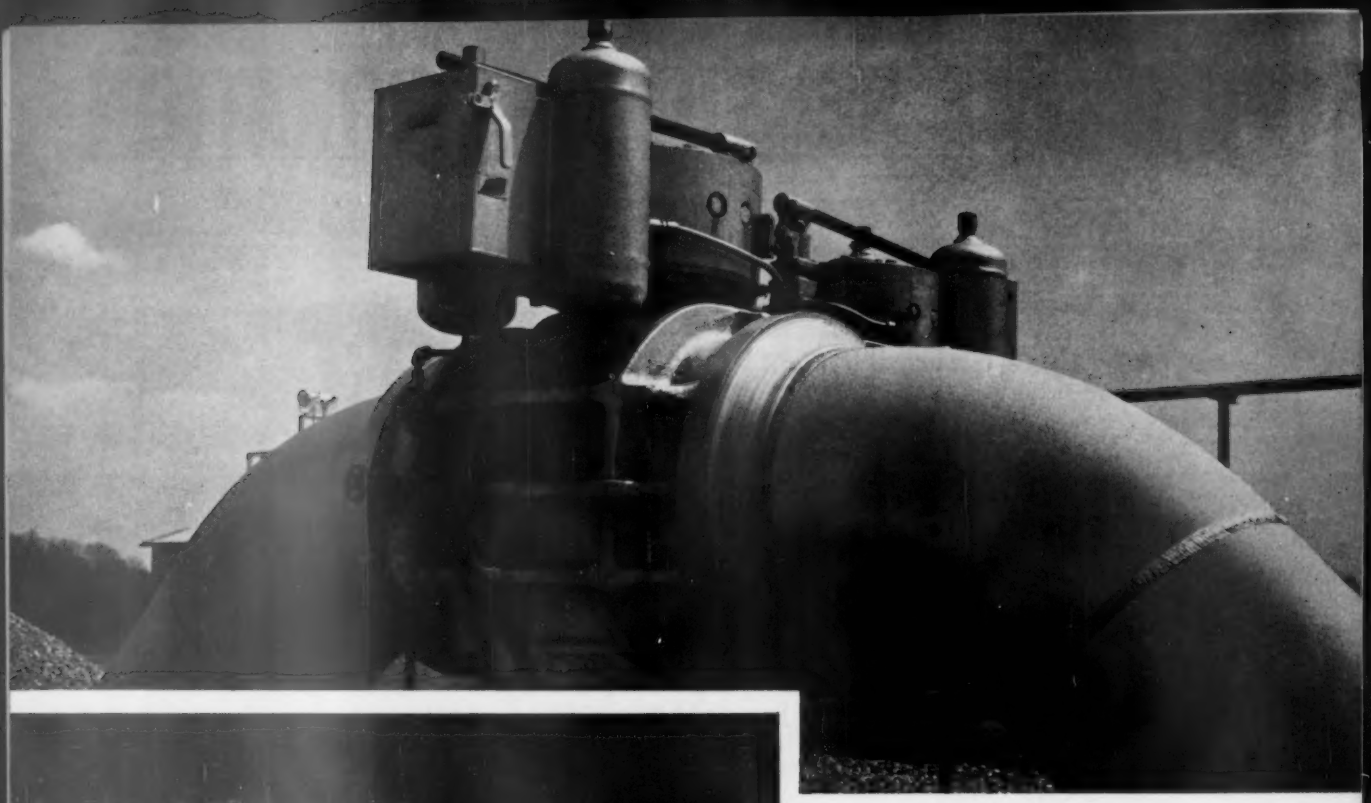

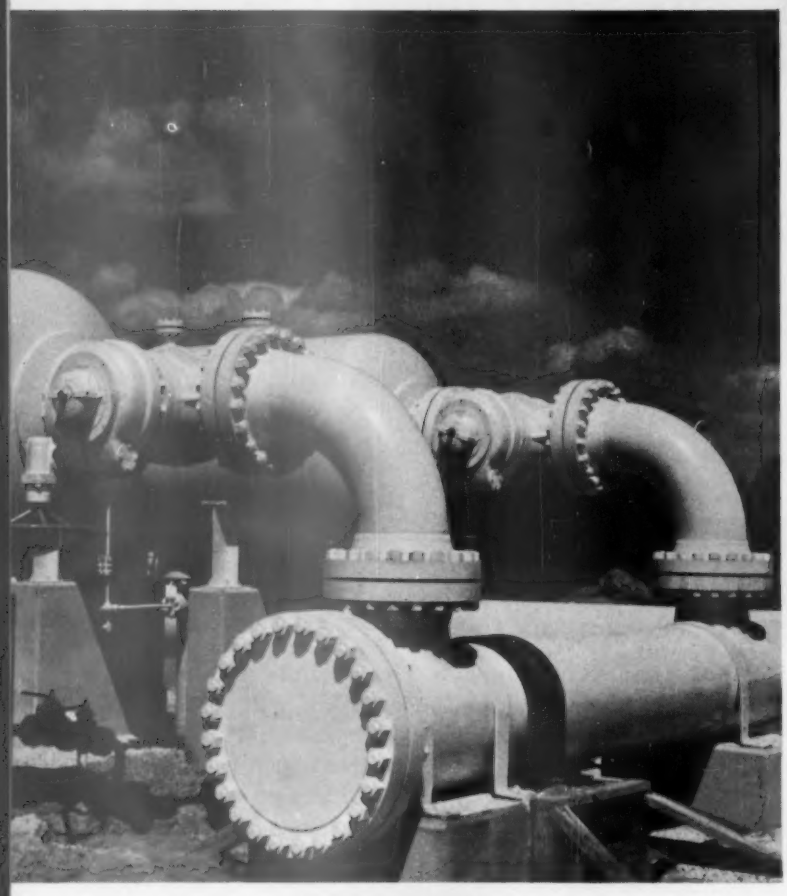

Men who plan and lay pipelines with J&L line pipe also prefer famous names in valves and fittings. Rockwell-Nordstrom, OIC, W-K-M, Stockham, Taylor Forge . . . all products in the "best available" class. Taylor Forge WeldElls and flanges and Rockwell-Nordstrom lubricated plug valves are featured "on location" here.

For technical information on line pipe, valves and fittings, ask your local J&L Supply man or write us at Tulsa — Drawer 2481. J&L electricweld line pipe is available in sizes from 6⅝" through 12¾" O.D.; J&L seamless line pipe from 2⅜" through 14" O.D.

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PIPE LINE SERVICE CORPORATION

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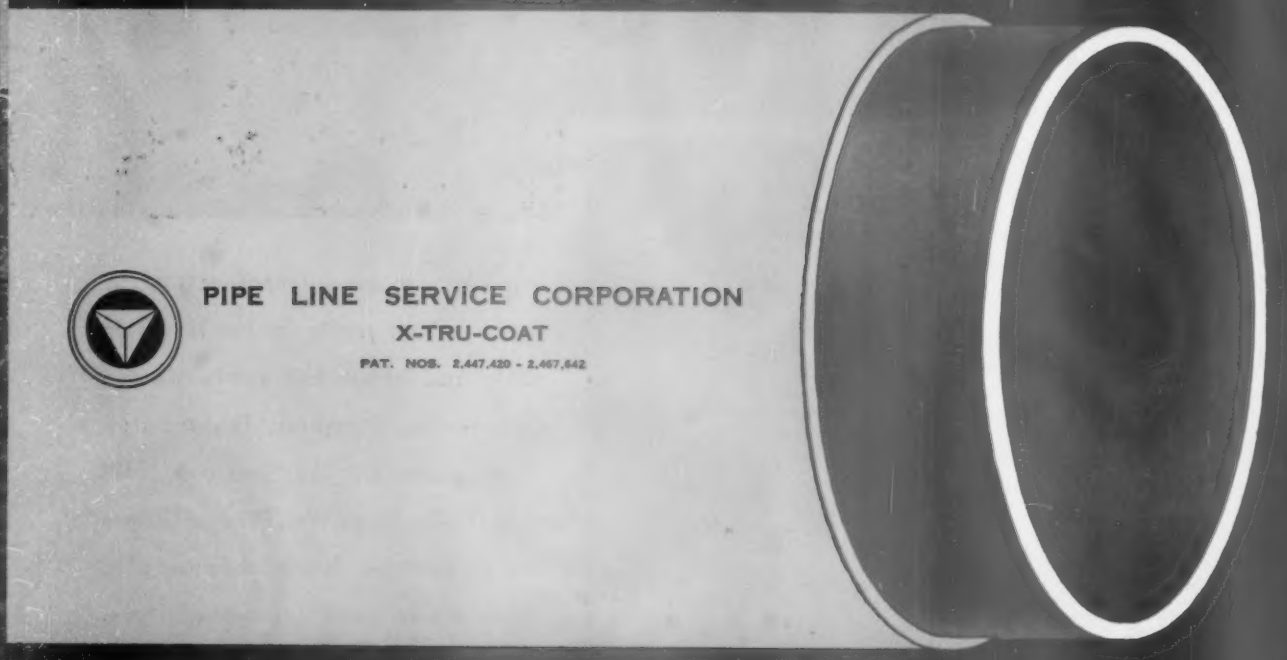

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They Say—

Air Pollution Survey Deserves Distribution

Dear Sir:

As chairman of the information committee, a subcommittee of the API's air and water conservation committee, I'm convinced that the air pollution study (OGJ, Feb. 20, p. 105) will be most helpful in our communications program within, as well as without, the industry.

It provides a most helpful reference in our basic communications plan. I view Dave Stormont's article as a substantial Oil and Gas Journal contribution to our industry.

G. A. Lloyd
Esso Standard Division
Humble Oil & Refining Co.

Dear Sir:

We found your report on air pollution control most interesting and informative and trust that it gets wide distribution, careful reading, and appropriate implementation in the oil industry.

This department receives frequent requests from the public for information about air pollution and its control and we should like to give such persons copies of this report if reprints are available.

Congratulations to you and your staff on a very fine job.

Arthul J. Benline
Commissioner
City of New York
Department of
Air Pollution Control

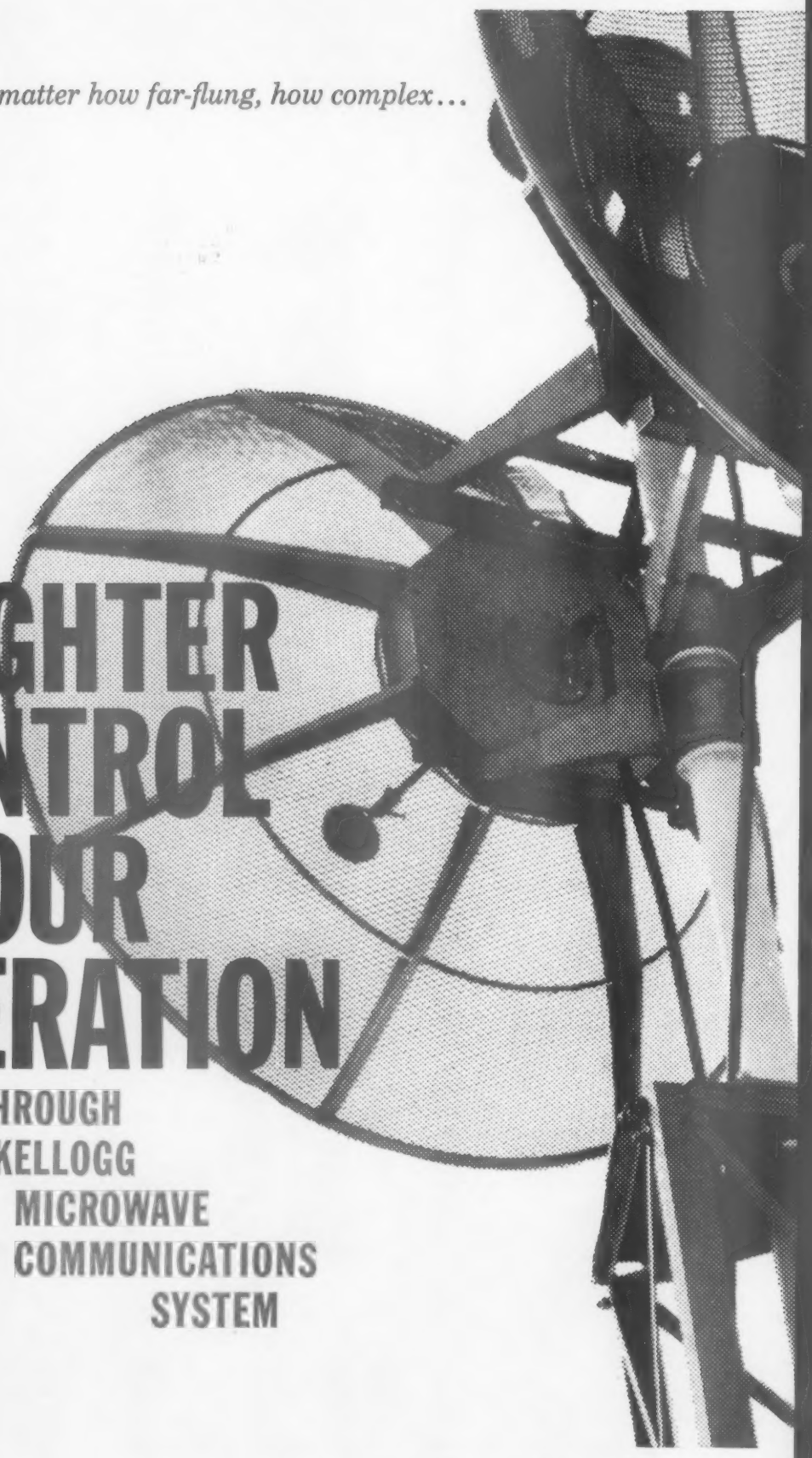
Reprints are available from Reader Service, Box 1260, Tulsa.—Ed.

Dear Sir:

Congratulations on the air pollution survey and the story covering it.

Once again you have rendered what I think is an extremely important service to the industry. It is a credit both to the Journal and to Dave Stormont personally. The

no matter how far-flung, how complex...



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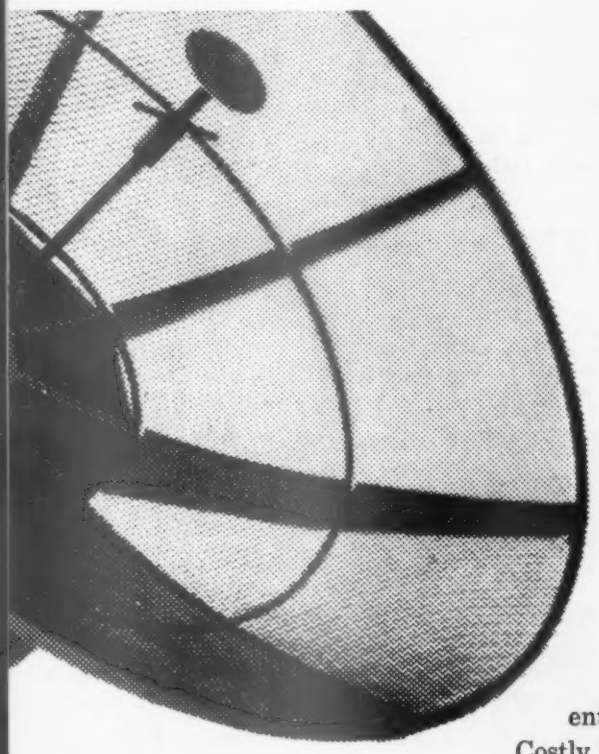

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interpretations which you put on the facts developed by your survey were just about right, being accurate, constructive, and positive.

Jerry McAfee
Vice President
Gulf Oil Corp.

Publicity pitfalls

"In presenting a message to the public, you should never underestimate their intelligence or overestimate their information."

Monroe E. Spaght, president, Shell Oil Co., quoted in a recent issue of Shell News.

Letters to They Say should be addressed to The Editor, The Oil and Gas Journal, Box 1260, Tulsa, Okla.

CALENDAR

MARCH

13-16 Kentucky Petroleum Marketers Association, sixth management institute, conducted by the University of Louisville, Brown Hotel, Louisville.

13-17 National Association of Corrosion Engineers, annual meeting and corrosion show, Hotel Statler, Buffalo, N. Y.

15-17 Natural Gasoline Association of America, annual convention, Baker Hotel, Dallas.

16-17 International Oil and Gas Educational Center, study of the economics of petroleum exploration, development, and property valuation, Southwestern Legal Center, Dallas.

20 American Gas Association, general management section conference, Francis Marion Hotel, Charleston, S. C.

21-23 American Power Conference, twenty-third meeting, Sherman Hotel, Chicago.

21-30 American Chemical Society, 139th annual meeting, Kiel Auditorium, St. Louis.

22 American Institute of Chemical Engineers, Chicago section, symposium on new developments for chemical processing and new developments for the engineer and management, Conrad Hilton Hotel, Chicago.

22-24 American Petroleum Institute, Division of Production, southwestern district meeting, Cole Hotel, Albuquerque.

23 National Industrial Conference Board, general session, Shamrock-Hilton Hotel, Houston.

23-24 North Texas Oil and Gas Association, annual meeting, Kemp Hotel, Wichita Falls, Tex.

27-28 University of Wichita, School of Engineering, third annual production institute, university campus, Wichita.

27-29 Midwest Gas Association, annual meeting and convention, Sheraton-Fontenelle Hotel, Omaha.

27-29 Society of Petroleum Engineers of AIME, Saudi Arabia section, regional meeting, Dhahran, Saudi Arabia.

27-31 Instrument Society of America, symposium on temperature measurement and control in science and industry, Veterans Memorial Auditorium, Columbus, Ohio.

28 Canadian Petroleum Association, annual general meeting, Hotel Palliser, Calgary.

28-29 University of Oklahoma, Schools of Petroleum and Gas Engineering, gas conditioning short course, Oklahoma Memorial Union Building, University of Oklahoma, Norman.

APRIL

4 Instrument Society of America, New Jersey section, annual symposium on electronic process instrumentation, Hotel Essex House, Newark, N. J.

4-5 University of Kansas, gas compressor institute, Liberal, Kans.

5-6 Third annual symposium on pilot plant and process automation, Ambassador Hotel, Los Angeles.

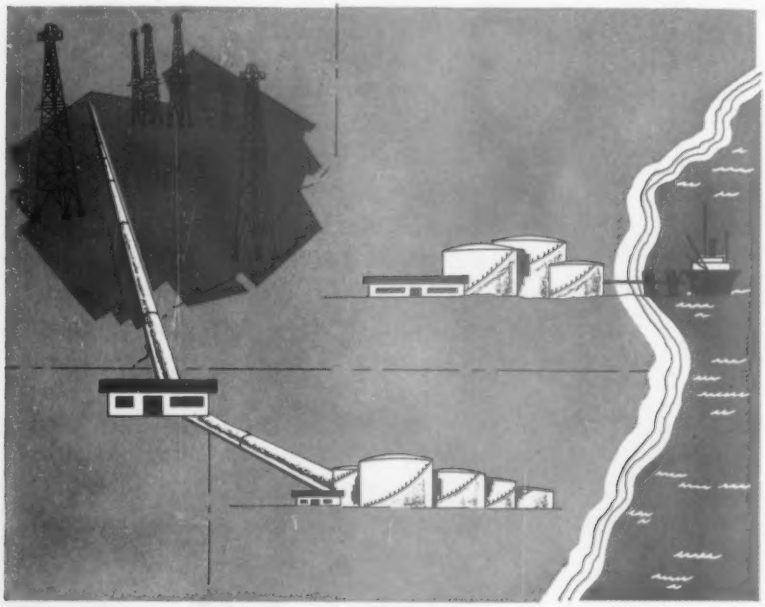
5-7 American Petroleum Institute, Division of Production, Mid-Continent district meeting, Mayo Hotel, Tulsa.

6-7 University of Oklahoma, School of Mechanical Engineering, short course on industrial engines, University of Oklahoma, Norman.

6-8 Texas Oil Jobbers Association, Petroleum Marketers Association, convention and trade show, Baker Hotel, Dallas.

8-12 Petroleum Equipment Suppliers Association, annual meeting, The Greenbrier, White Sulphur Springs, W. Va.

10-11 American Society of Mechanical Engineers, maintenance and plant engi-



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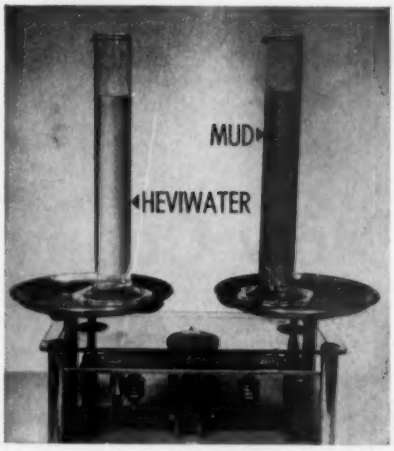
10-12	Western Petroleum Refiners Association, annual meeting, Granada Hotel, San Antonio, Tex.
10-13	American Society of Mechanical Engineers, oil and gas power conference and exhibit, Jung Hotel, New Orleans.
11-13	Petroleum Industry Electrical Association and Petroleum Electric Supply Association, annual conference, Moody Convention Center, Galveston, Tex.
12-14	Investment Bankers Association of America, annual convention of the Texas group, Shamrock Hilton Hotel, Houston.
14	American Institute of Chemical Engineers, St. Louis section, third annual symposium, Coronado Hotel, St. Louis.
17-19	Instrument Society of America, symposium on instrumental methods of analysis, Shamrock Hilton Hotel, Houston.
18-20	University of Oklahoma, southwestern gas measurement short course, North Campus, University of Oklahoma, Norman.
19-20	University of Tulsa, fifteenth annual conference of accountants, University campus, Tulsa.
19-20	National Petroleum Association, semi-annual meeting, Hotel Sheraton-Cleveland, Cleveland.
20-21	Society of Petroleum Engineers of AIME, East Texas-Louisiana-Arkansas gas-technology symposium, Tyler, Tex.
20-21	Texas Technological College, annual West Texas oil lifting short course, Lubbock, Tex.
20-22	Illinois Society of Professional Engineers, annual convention, Peoria, Ill.
24-26	Southern Gas Association, meeting, New Orleans.
24-27	American Association of Petroleum Geologists, Society of Economic Paleontologists, and Rocky Mountain section of AAPG, annual meeting, Denver Hilton Hotel, Denver.
26-28	American Petroleum Institute, Division of Transportation, pipeline conference, Chase-Park Plaza Hotel, St. Louis.
27-28	Rocky Mountain Oil and Gas Association, midyear meeting, Northern Hotel, Billings, Mont.
28	Natural Gasoline Association of America, Oklahoma regional meeting, Lake Murray Lodge, Ardmore, Okla.
29	American Institute of Chemical Engineers, Oklahoma state meeting, University of Tulsa, Tulsa.
30-May 2	Independent Petroleum Association of America, midyear meeting, Roosevelt Hotel, New Orleans.
30-May 3	Liquefied Petroleum Gas Association, convention and trade show, Conrad Hilton Hotel, Chicago.

MAY

2-4	Purdue University, School of Civil Engineering, sixteenth industrial-waste conference, Purdue Memorial Center, Lafayette, La.
3-5	American Petroleum Institute, Division of Production, Rocky Mountain district meeting, Gladstone-Henning Hotel, Casper, Wyo.
4-5	Society of Petroleum Engineers of AIME, oil recovery conference, Midland, Tex.
4-5	Pacific Coast Gas Association, Inc.,

HEVIWATER completion fluid avoids use of mud above packers



Heviwater* completion fluid is a solution of fresh water, calcium chloride, suitable corrosion inhibitors, and zinc chloride if fluid weights above 11.8 pounds per gallon are desired.

Since Heviwater is free of solids, it helps operators avoid problems such as pay contamination and the sticking of packers due to the settling out of solids.

Pre-mixed Heviwater saves rig time. In some cases, a full day of mixing time can be saved by using Heviwater.

Heviwater is pre-mixed to customer specifications at Berwick, Louisiana. With proper notice, Heviwater can be made available wherever this type of completion fluid is needed. Ask your Dowell representative for full information. *DOWELL TRADEMARK

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DIVISION OF THE DOW CHEMICAL COMPANY

Noel M. Champion *(left), Chief Engineer, Armour Agricultural Chemical Company, discusses a technical problem with* Robert L. Kietzman, *Sales Engineer, The Cooper-Bessemer Corporation, St. Louis District Office.*

How Cooper-Bessemer service helps keep the ammonia flowing

At Armour Agricultural Chemical Co., Crystal City, Missouri, nine Cooper-Bessemer compressors play key roles in the manufacture of ammonia products. Round the clock, for five years, these units have given exceptional performance under the rigors of such problems as handling pressures up to 9000 psi.

The performance of these C-B compressors has been backed by Cooper-Bessemer engineers in the St. Louis area and in Mt. Vernon, contributing helpful service for these high-pressure operations.

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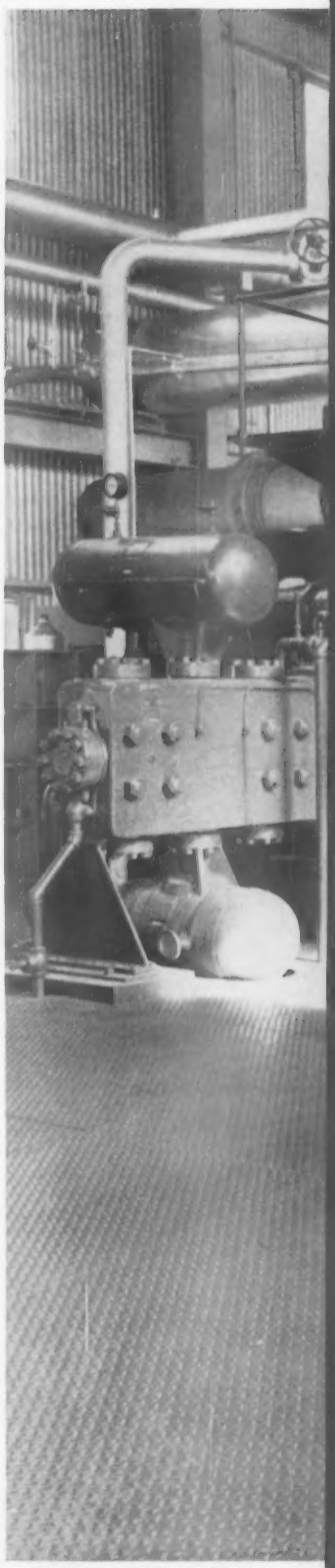
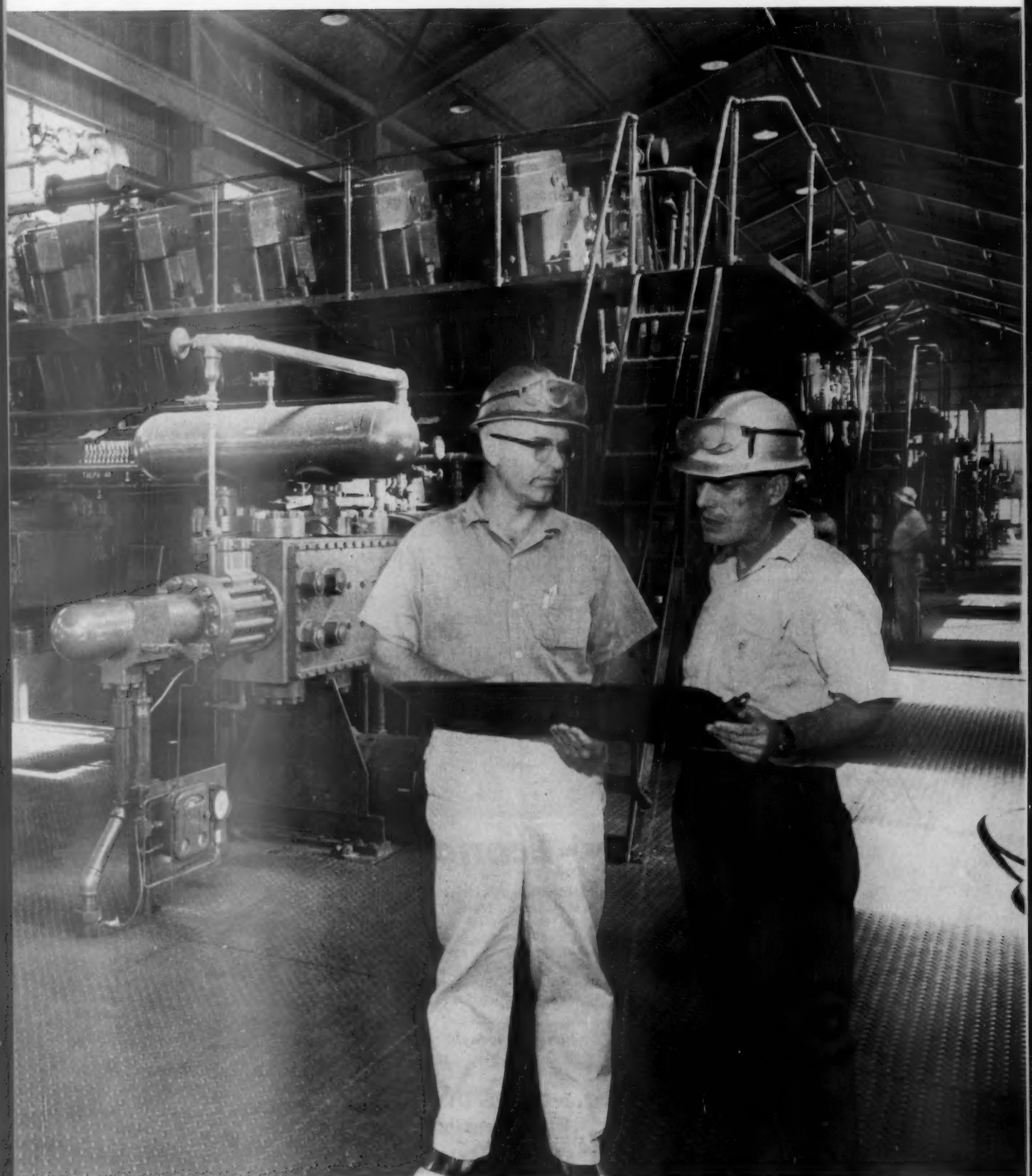




Noel M. Champion *(left) and* Thomas H. Ferebee, *Supt. Ammonia Plant. In background are two GMWA-10, four GMWA-8 and one GMWA-6 engine driven compressors for compression of air, natural gas, synthesis gas and ammonia. Armour also has two FM compressors for ammonia recirculators.*

transmission conference, Biltmore Hotel, Santa Barbara, Calif.

4-5 Illinois State Geological Survey, Illinois Basin chapter of AIME's Society of Petroleum Engineers, biennial petroleum engineering conference, University of Illinois campus, Urbana.

5-7 Indiana Geological Survey, Indiana Department of Conservation, University of Indiana department of geology, tenth geologic field conference, stratigraphy of the Silurian rocks of northern Indiana, Marion, Ind.

7-10 American Institute of Chemical Engineers meeting, Sheraton-Cleveland Hotel, Cleveland.

8-11 American Petroleum Institute, Division of Refining, midyear meeting, Rice Hotel, Houston.

8-12 American Gas Association, distribution and production conference, Sheraton Hotel, Philadelphia.

9-11 Western Joint Computer Conference and Exhibit, Ambassador Hotel, Los Angeles.

10-12 American Society of Mechanical Engineers, production engineering conference, Royal York Hotel, Toronto.

10-12 Canadian Institute of Mining and Metallurgy, oil and gas division, and Calgary and Edmonton petroleum engineering sections of Canadian Institute of Mining and Metallurgy and American Institute of Mining, Metallurgical, and Petroleum Engineers, annual meeting, McDonald Hotel, Edmonton, Alta.

11-12 American Petroleum Institute, Division of Production, Pacific Coast district meeting, Biltmore Hotel, Los Angeles.

11-12 Texas A. & M. College, thirteenth oil recovery conference, College Station, Tex.

12 Natural Gasoline Association of America, Permian basin regional meeting, Lincoln Hotel, Odessa, Tex.

14-17 Texas Independent Producers and Royalty Owners Association, Scharbauer Hotel, Midland, Tex.

16-19 American Petroleum Institute, Division of Marketing, midyear meeting, Americana Hotel, Miami Beach.

17-19 Western Petroleum Refiners Association, Mid-Continent regional technical-industrial relations meeting, Hotel Lassen, Wichita.

17-19 Society of Professional Well Log Analysts, second annual meeting and logging symposium, Sheraton-Dallas Hotel, Dallas.

19 Natural Gasoline Association of America, Permian Basin regional meeting, Lincoln Hotel, Odessa, Tex.

21-24 American Petroleum Institute, Division of Transportation, midyear highway conference, Bellevue Stratford Hotel, Philadelphia.

24-25 Western Petroleum Refiners Association, computer conference, Ben Franklin Hotel, Philadelphia.

25 Pennsylvania Grade Crude Oil Association, annual meeting, Pennhills Club, Bradford, Pa.

25-26 American Institute of Mining, Metallurgical, and Petroleum Engineers, annual Rocky Mountain petroleum sections, joint meeting, Salt Lake City.

25-26 American Gas Association, gas transmission conference, Brown Palace and Cosmopolitan Hotels, Denver.

JUNE

1-2 Kentucky Oil and Gas Association, annual meeting, Phoenix Hotel, Lexington.

5-6 Petroleum Electric Power Association, meeting, Mayo Hotel, Tulsa.

6-8 Instrument Society of America, summer instrument - automation conference and exhibit, Royal York Hotel and Queen Elizabeth Hall, Toronto.

6-8 Sixth annual Appalachian underground corrosion short course, West Virginia University, School of Mines, Morgantown, W. Va.

9-17 European Congress of Chemical Engineering and Achema Congress, thirteenth exhibition and congress of chemical engineering, Frankfort am Main, Germany.

11-15 American Society of Mechanical Engineers, summer annual meeting, Statler Hilton Hotel, Los Angeles.

12 Instrument Society of America and Air Pollution Control Association, air pollution instrumentation symposium, Hotel Commodore, New York City.

12-14 American Petroleum Institute, Division of Transportation, annual tanker conference, Oyster Harbors, Cape Cod, Mass.

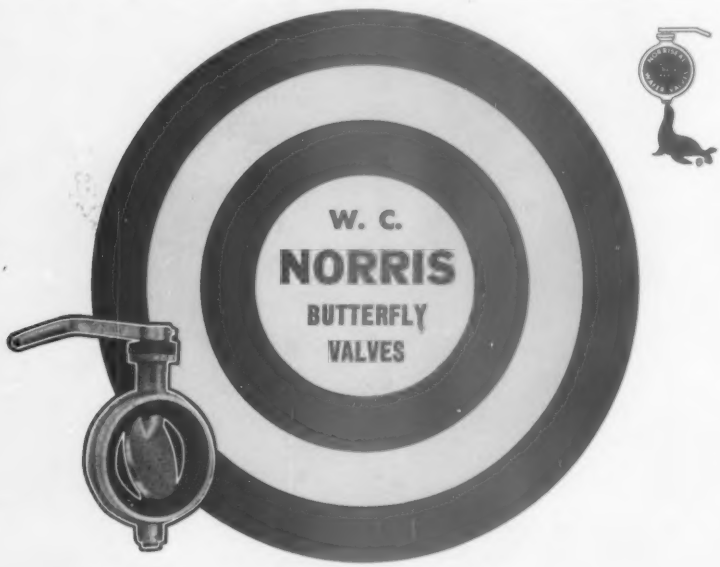
13-16 Instrument Society of America, biennial international gas chromatography symposium, Kellogg Center, Michigan State University, East Lansing, Mich.

19-21 Interstate Oil Compact Commission, midyear meeting, Shamrock - Hilton Hotel, Houston.

19-23 Harvard University, School of Public Health, air cleaning institute, Cambridge, Mass.

20-24 Canadian Gas Association, annual meeting, Banff Springs, Alta.

25-30 American Society for Testing Materials, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.



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B&W Welding Fittings manufacturing is integrated with the Division's own tube-making and steel-making facilities. Consider the relation between tube-making and the manufacture of welding fittings . . . in addition to knowing welding fittings manufacturing, B&W knows of the making of tubing from which fittings are produced. This knowledge plus integration of facilities permits B&W to provide superior fittings, completely quality-controlled, matched to end-use service. It also means on-time deliveries of fittings made from tubing of the specialized steels because B&W can closely control manufacturing schedules from melt to the shipment of the finished product.

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50 years ago

March 16, 1911

Department of Justice at Washington exonerates Gulf Pipe Line Co., The Texas Co., and Prairie Oil & Gas Co. of the accusation they are in a combine to oppress Oklahoma oil producers. Decision ends year of investigation.

Bankruptcy and arrests on government charges of fraud end escapades of Burr Brothers, Inc., notorious oil-promotion firm which took more than $50,000,000 from the public in sales of alleged worthless stock. Wall street speculation strips firm's partners of their rich gains.

Natural-gasoline manufacturers in their budding young industry are encountering trouble in shipping and storing their new product. They are trying hard to make steel drums that will meet their needs.

25 years ago

March 12, 1936

Completion by Hamman Exploration Co. of a 9,439-ft. well south of Bay City, in Matagorda County, Texas Gulf Coast, not only opens a new field (Bay City), but also sets a new producing depth record for the state. The well, 1 Cleveland, flowed 250 bbl. of 33.8°-gravity oil daily through 3/16-in. choke from Frio sand at 9,361-70 ft. The producing depth is only a little more than 100 ft. shallower than the deepest production on the entire Gulf Coast, located at Lafitte, in South Louisiana.

Eyes of South Texas oil industry turn to Pearsall field in Frio County, as No. 1 spot as Amerada Petroleum Corp.'s 6 Halff & Oppenheimer well comes in flowing more than 22,000 bbl. daily from Austin Chalk at 5,394-5,467 ft. The well, on an 85,000-acre block, is one of the largest ever completed in Southwest Texas.

10 years ago

March 15, 1951

Sun Oil Co. unveils new high-speed reservoir analyzer—an electronic device for predicting the behavior of new pools. Revolutionary tool is expected not only to speed reservoir studies but also facilitate adoption of more effective producing techniques early in a field's life.

The Arkansas legislature passes a law giving the Oil & Gas Commission the right and power to unitize an oil or gas field when it is deemed necessary for proper conservation.

Buckeye Pipe Line Co. will lay a common-carrier products pipeline linking seaboard refining centers in New Jersey and Pennsylvania with eastern Pennsylvania and Central New York markets. New system will comprise 430 miles of new line and cost $23,400,000.

JOURNALLY SPEAKING

On the Record

NOT TO BRAG, but simply to get it on the record because people keep asking: Yes, our favorite oil publication is still the biggest magazine of any kind anywhere in the world.

If you're interested in the figures, you'll find the 1960 scoreboard on Page 59 of this issue, with a picture of somebody's baby (cute, isn't he?) grinning at them and saying "Gee whiz . . . Again."

The reaction of our advertising department was more like "Whew . . . It was a tough fight, Ma, but we won."

Since there are no secrets in the publishing business we might as well admit that we carried fewer pages of advertising last year than we did in 1959 (things are tough all over—or hadn't you heard?). But all the other mags dropped ad space too, so we all went down more or less together and the Big Yellow Book is still top dog.

But while we all take a certain pride in knowing that we are the *ne plus ultra* of the publishing business, those of us in the editorial department are more interested in being the *sine qua non* of the petroleum business. In case your Latin is rusty, a free translation of those phrases would be "none is more bigger," and "without it you're nothing."

In other words, we're more concerned with the quality of what we put on the pages than with the number of pages we have to put it on. If we can nake the old Journal indispensable to all oil men who can read, we have little more than academic interest in the knowledge that we are bigger than *The New Yorker* or *Saturday Evening Post*, or even *The Florists' Review*.

But whenever we see figures like those on Page 59 we are struck with the contrast between the publishing business and most other businesses. We live in a goldfish bowl. Everything is on the record.

There are old jokes to the effect that when a doctor makes a mistake he buries it; when a lawyer makes a mistake he files an appeal; but when an editor makes a mistake it stays right out there in public where everybody can see it.

There's more to it than that. Oil companies don't like to have such agencies as FPC (or even Journal editors) pry into their activities. But everything we do is on the record.

Anybody can count our pages of advertising (and don't think our competitors don't), and there are trade magazines of the publishing industry that print the totals regularly. Our prices are open, too. We'll hand out a rate card to anybody, and several directories list the ad rates of all magazines.

Our subscription price is printed in every issue, and twice a year the Audit Bureau of Circulations releases a sworn, audited statement showing a detailed breakdown of the occupations and locations of everybody who's paid up.

How would oil companies like it if similar details of their business were on the record and available to their competitors?

We don't mind it. In fact, we like to know what our competitors are doing. We think it's a healthy way to run an industry to have everything on the record.

Maybe that's why we journalists have such an inborn avidity to put the oil industry's business on the record.

With full details of our own business—mistakes and all, even down to typographical errors—exposed to public view, we sort of assume that everybody else's business should be laid just as bare.

So we editors make it our business to put on the record all we can find out about the oil business. And if our success in doing so has the incidental effect of making The Oil and Gas Journal the biggest magazine in the world, it *is* gratifying.

—*Henry D. Ralph.*

BAKER WIRE LINE BRIDGE PLUG, PRODUCT 400-N

RELIABLE BRIDGE PLUG

In average wells or tough ones, its dependability is a matter of record.

Here is a bridge plug that commands a lot of respect. The evidence has been piling up for years that this is probably the most dependable bridge plug available anywhere.

It's got time on its side. Over the years we've refined it into a tool with a tremendous ability to take whatever comes its way downhole.

Whether you measure its life span in hours or in years, a Baker Bridge Plug masters the hydraulic forces in any well—from average wells to the hot, high pressure wells. Reliable is the right word for it.

Leading wire line companies set Baker Wire Line Bridge Plugs accurately and promptly. Other models can be set on tubing or drill pipe. They're made in drillable cast iron for permanent service, and in fast-drilling magnesium for temporary service.

BAKER

BAKER OIL TOOLS, INC. HOUSTON / LOS ANGELES / NEW YORK

Oil is missing the boat in Washington

NEVER in all its history has the oil industry needed a good spokesman in Washington as badly as it needs him now.

There is no crisis. But when there's a crisis it's too late to do much. A capable voice now could prevent a crisis. Right now the new Kennedy administration is completing its staff, formulating its policies, and sizing up the oil business. It is asking for facts and advice.

So right now is the time for oil to have a forthright, broad-visioned representative on the ground, one who can channel the views of the whole industry and speak in terms understood by government officials.

THE API OUGHT to have supplied this need long since. It is supposed to represent all segments of the industry on a national level and to be the chief liaison with the Government. That's the main thing it was organized for back in the 1920's.

Many oil and gas groups have Washington offices staffed with contact men, researchers, and public-relations men. That's fine as far as it goes. But they can't—and shouldn't pretend to—reflect the over-all position of the petroleum industry as a whole.

The API does have a Washington office, but as now operated it doesn't do the job that many of its dues-paying members think should be done. There have been suggestions that a new organization be created for the purpose if API feels that this is not its role.

Current reports are that API would like to hire some former congressman, somebody who "knows his way around the Hill" and who will work unobtrusively behind the scenes.

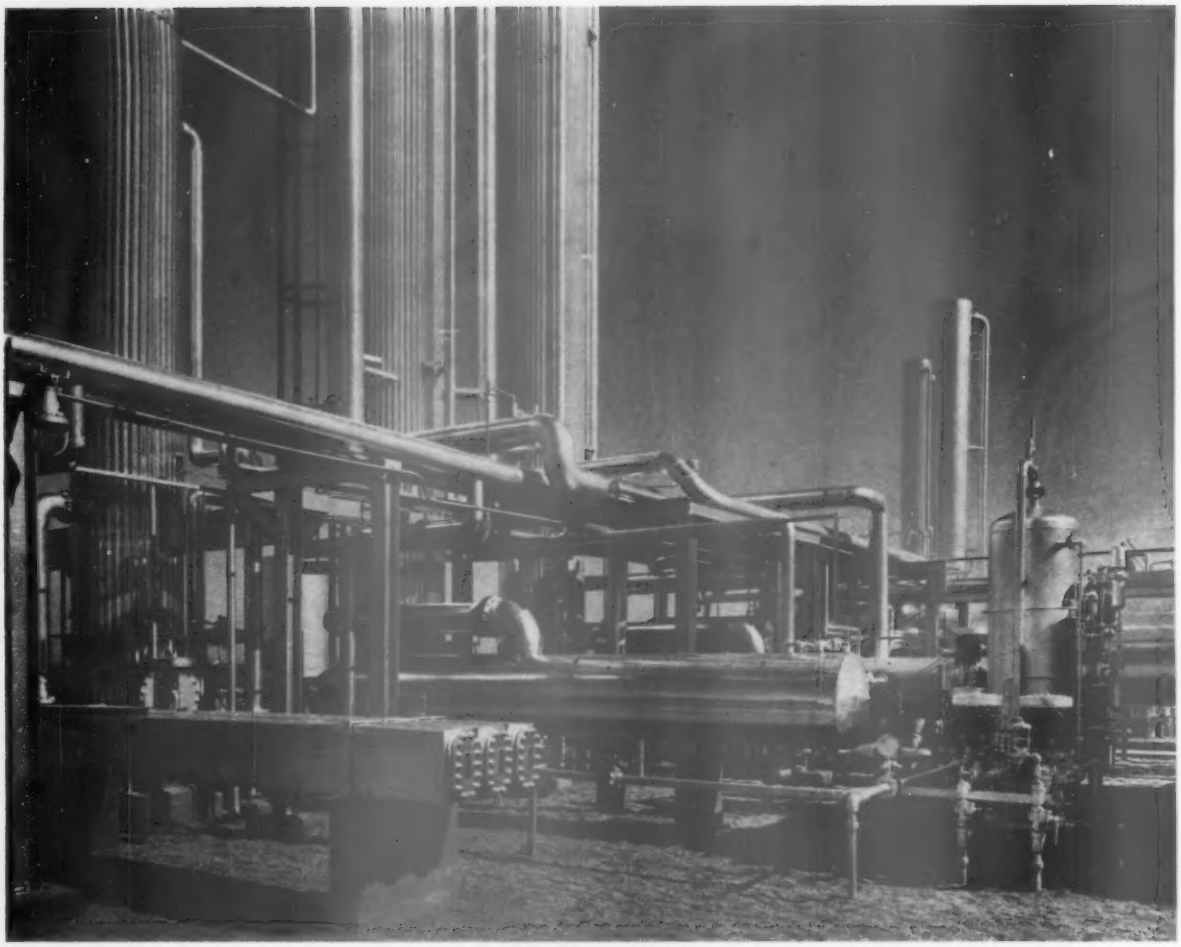
That isn't what's needed. The industry can supply plenty of such if required. But why try to worm through the back door when the front door is open and the welcome mat is out?

What's needed is a real oil man. A man with enough practical background to fairly state views of any element of the business and who is articulate enough to do so. One who can level with the administration. Who will speak out promptly when occasion demands—without having to get his statement cleared by 17 lawyers and company presidents.

MANY OTHER INDUSTRIES have Washington spokesmen who do just that. They are widely recognized and respected for it. They are consulted and trusted by opinion formers among officialdom and the press.

Oil interests have a whole bevy of Washington agents, observers, reporters, lobbyists, attorneys, and gumshoe men. They send back endless reports of what's going on. They talk to themselves. But nobody speaks for the industry.

There's much doing in Washington. The atmosphere is one of learning now in preparation for action soon. Oil should be in step with the times, right in there among them.



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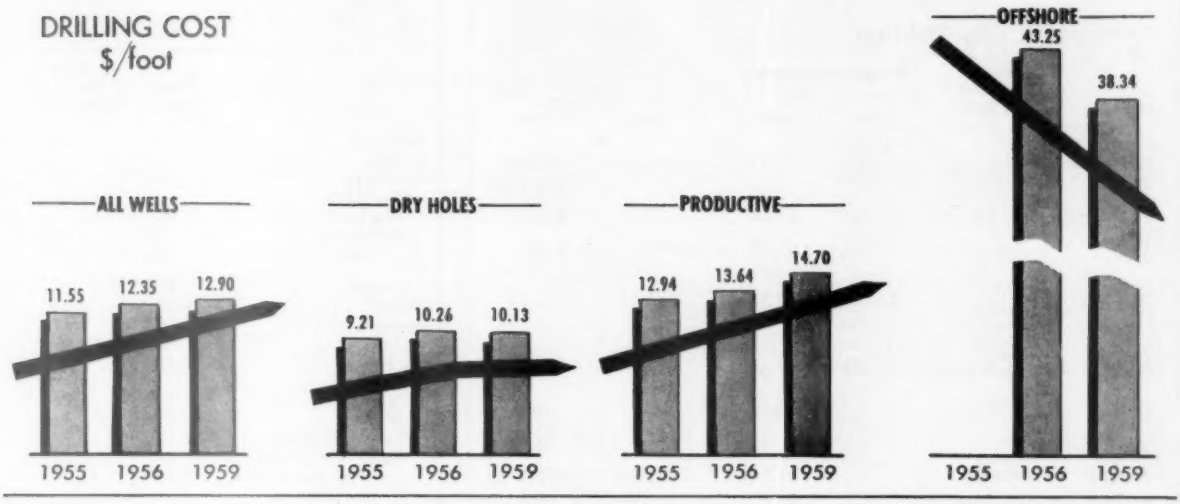


Drilling Costs Still Going Up Onshore

- Better technology has cut expenses offshore and at depths below 15,000 ft. But cost of drilling the average U. S. well has jumped $3,300 in 3 years. One reason: Costs of gas wells are almost twice as much as oil wells.

DEEPER DRILLING and the rising prices of materials are pushing up the industry's over-all costs of drilling and equipping wells.

But there are two exceptions to that general trend. Significant reductions have been made in two categories—offshore and the extreme depths below 15,000 ft.

These are among the highlights of the third joint drilling-cost study made by the American Petroleum Institute, the Mid-Continent Oil and Gas Association, and the Independent Petroleum Association of America.

The study, based on 1959 data, is more comprehensive than the 1955 and 1956 studies (OGJ, June 1, 1959, p. 89). Oil and gas wells are examined separately for the first time.

A comparison of the 1959 survey with 1956 discloses these significant changes:

... **Average well cost** increased from $50,200 to $53,500.

... **Average dry-hole** cost increased from $41,600 to $43,000.

... **Average producing-well** cost increased from $55,600 to $60,100.

... **Cost per foot** increased from $13.64 to $14.70 for productive wells and from $12.35 to $12.90 for all wells. But it decreased slightly from $10.26 to $10.13 per foot for dry holes.

... **Offshore costs** declined, from $415,000 to $383,000 per well, and from $43.28 to $38.34 per foot, although the average depth per well increased by about 400 ft.

... **Incremental costs** dropped 34% from $154.10 per foot to

Key 1959 Drilling Figures

	Oil	Gas	Dry	All Wells
Wells drilled	25,413	5,049	19,101	49,563
Footage drilled (thousands	96,931	27,585	80,996	205,512
Expenditures (millions	$1,321	$509	$821	$2,651
Average depth	3,814	5,464	4,240	4,146
Average cost per well	$52,000	$100,700	$43,000	$53,500
Average cost per foot	$13.63	$18.45	$10.13	$12.90

How Depth Affected Costs

Depth Range (Feet)	Number of Wells	Averaget Depth (Feet)	Total Cost Per Foot	Average Cost Per Well
0- 1,250	6,977	765	$ 7.84	$ 6,000
1,251- 2,500	9,873	1,830	7.74	14,200
2,501- 3,750	11,439	3,115	8.70	31,200
3,751- 5,000	6,578	4,370	8.96	39,200
5,001- 7,500	8,040	6,175	10.70	66,000
7,501-10,000	3,679	8,655	15.00	129,800
10,001-12,500	1,943	11,175	20.29	226,800
12,501-15,000	814	13,480	28.08	378,700
Over 15,000	220	16,115	40.71	656,100
Total	49,563	4,145	12.90	53,500

Drilling Trends

Offshore Costs Decline

	Footage (thousands)		Cost/Foot	
	1956	1959	1956	1959
California	111	114	$34.58	$34.46
Florida	....	29	.....	$50.34
Louisiana	4,122	4,584	$42.89	$38.19
Texas	361	30	$50.33	$64.13
Total	4,594	4,757	$43.25	$38.34

Wells Go Deeper, Cost More

	1955	1956	1959
Wells drilled	55,931	57,125	49,563
Footage (thousands)	225,157	232,174	205,512
Expenditures (millions)	$2,600	$2,868	$2,651
Average depth	4,026	4,064	4,164
Cost per well	$46,500	$50,200	$53,500
Cost per foot	$11.55	$12.35	$12.90

Some Deep Drilling Gets Cheaper

Average cost per foot of drilling and equipping productive wells in various depth ranges

Depth Range	1955	1956	1959
0- 1,250	....	....	....
1,251- 2,500	$ 8.56	$ 8.50	$ 8.98
2,501- 3,750	11.51	11.30	11.39
3,751- 5,000	12.33	11.70	11.91
5,001- 7,500	15.05	17.80	17.85
7,501-10,000	24.71	22.70	27.48
10,001-12,500	43.93	46.40	41.06
12,501-15,000	52.35	62.30	72.79
Over 15,000	95.44	154.10	101.50

State-by-State Rundown

	Oil Wells		
State	Wells Drilled	Total Footage (1,000 Ft.)	Cost ($1,000)
Alabama	70	803	9,9
Alaska	6	59	4,7
Arkansas	462	1,394	11,9
California:			
Onshore	857	3,774	78,3
Offshore	27	103	3,6
Total	884	3,877	81,9
Colorado	160	820	8,8
Illinois	1,009	2,381	22,3
Indiana	295	453	4,8
Kansas	1,760	6,031	59,0
Kentucky	2,146	1,511	14,7
Louisiana:			
North	752	1,986	17,5
South	818	7,765	175,1
Total Onshore	1,570	9,751	192,7
Total Offshore	249	2,486	84,7
Total Louisiana	1,819	12,237	277,5
Michigan	241	713	9,0
Mississippi	251	2,543	41,2
Montana	168	822	11,0
Nebraska	293	1,755	13,4
New Mexico:			
Northwest	410	1,213	15,9
Southeast	829	3,721	52,3
Total	1,239	4,934	68,2
North Dakota	273	1,817	24,6
Oklahoma	2,677	9,606	111,0
Texas:			
Dist. 1 & 4	917	2,898	32,0
Dist. 2 & 3	681	3,804	48,2
Dist. 5 & 6	715	2,589	27,0
Dist. 7B & 9	3,093	8,129	69,2
Dist. 7C & 8	4,035	19,757	269,4
Dist. 10	762	3,077	39,4
Offshore	1	10	4
Total	10,204	40,264	485,9
Utah	183	1,047	19,4
Wyoming	371	1,745	26,7
Appalachian*	881	1,991	12,7
Other States†	21	128	1,7
TOTAL UNITED STATES	25,413	96,931	1,321,4

*Includes N. Y., Ohio, Penn., and W. Va. †Includ

$101.50, below 15,000 ft., and 11.5%, from $46.40 to $41.06, between 10,001 and 12,500 ft. Incremental costs increased in the other six depth categories.

. . . **Gas wells,** broken out for the first time in the 1959 survey, cost almost twice as much to drill and equip as oil wells—$100,700 as against $52,000. The average cost per foot for a gas well was $18.45 compared with $13.63 for an oil well. Principal reason for the spread was the greater depth of gas wells.

Survey methods . . . Estimated drilling expenditures in the 1959 survey were again based on reports of drilling activity as published in The Oil and Gas Journal and on an extensive sample of actual expenditures by both large and small companies.

The 1959 survey embraces 240 producers accounting for 27% of the wells and 37% of total footage.

Estimates include all charges for drilling and equipping wells up to and including the christmas tree. They exclude exploration, development, and production costs, which will be reported later in Part 2 of the survey. Service wells also are excluded.

What trends mean . . . The major factor in the steadily rising costs, in addition to inflation, is the cost of deep drilling.

Total wells drilled in 1959 declined 13% from 1956 and footage was down 11.5%. But the $2.7 billion spent in 1959 for drilling and equipping wells was only 7.5% less than the 1956 total.

Depth figures show why costs didn't decline more.

In 1959, 18% of the total footage and 6% of all wells drilled were in the three deepest brackets—below 10,000 ft. In 1956, less than 15% of the footage and 5% of all wells were in the deeper zones.

Comparing 1959 with 1955, the average 1959 well was 3.4% deeper, and cost 11.6% more per foot and 15% more per well. The average 1959 productive well was 1.9% deeper, cost 13.6% more per foot and 15.8% more per well. The average 1959 dry hole was 4.6%

of 1959 Wells, Footage and Drilling Expenditures

Gas Wells			Dry Holes			Total All Wells		
Wells Drilled	Total Footage (1,000 Ft.)	Cost ($1,000)	Drilled Wells	Total Footage (1,000 Ft.)	Cost ($1,000)	Wells Drilled	Total Footage (1,000 Ft.)	Cost ($1,000)
			25	144	1,236	95	947	11,223
3	26	1,210	9	105	19,863	18	190	25,810
41	203	4,786	334	1,257	8,980	837	2,854	25,672
74	358	5,599	510	2,847	39,162	1,441	6,979	123,087
			2	11	324	29	114	3,928
74	358	5,599	512	2,858	39,486	1,470	7,093	127,015
88	501	11,263	560	2,896	30,581	808	4,217	50,670
9	7	56	1,062	2,258	11,088	2,080	4,646	33,451
11	10	112	566	842	2,842	872	1,305	7,851
183	818	9,117	1,937	7,047	39,218	3,880	13,896	107,414
289	861	8,347	893	1,123	7,172	3,328	3,495	30,271
164	798	13,512	601	2,604	17,494	1,517	5,388	48,599
319	3,940	111,753	706	7,490	130,294	1,843	19,195	417,219
483	4,738	125,265	1,307	10,094	147,788	3,360	24,583	465,818
74	886	47,615	118	1,212	42,682	441	4,584	175,047
557	5,624	172,880	1,425	11,306	190,470	3,801	29,167	640,865
54	144	1,662	308	1,016	7,411	603	1,873	18,145
32	308	5,342	362	3,225	32,197	645	6,076	78,786
11	33	846	169	766	9,614	348	1,621	21,552
2	10	79	616	3,665	13,808	911	5,430	27,364
377	1,700	27,190	112	349	4,708	899	3,262	47,806
50	292	4,532	302	1,472	21,838	1,181	5,485	78,744
427	1,992	31,722	414	1,821	26,546	2,080	8,747	126,550
5	58	1,414	158	912	8,205	436	2,787	34,264
498	3,108	51,251	2,072	7,317	62,478	5,247	20,031	224,801
357	2,251	37,381	1,131	4,650	37,441	2,405	9,799	106,838
412	3,261	54,164	902	5,912	59,991	1,995	12,977	162,427
98	678	9,084	429	2,142	15,961	1,242	5,409	52,064
205	977	11,250	2,553	7,566	39,825	5,851	16,672	120,315
128	904	19,788	1,216	6,154	76,358	5,379	26,815	365,558
277	1,276	18,527	221	1,182	13,041	1,260	5,535	71,029
1	11	973	1	9	470	3	30	1,924
1,478	9,358	151,167	6,453	27,615	243,087	18,135	77,237	880,155
16	65	1,110	119	626	11,838	318	1,738	32,442
77	505	12,464	501	2,570	34,550	949	4,820	73,759
1,182	3,546	37,765	492	1,315	15,146	2,555	6,852	65,633
12	50	703	114	312	4,959	147	490	7,403
5,049	27,585	508,895	19,101	80,996	820,775	49,563	205,512	2,651,096

rizona, Florida, Iowa, Maryland, Missouri, Nevada, North Carolina, Oregon, South Dakota, Tennessee, Virginia, and Washington.

deeper, cost 10% more per foot and 15.3% more per well.

Within the general pattern of deeper and more costly drilling, the 1959 survey also pointed up the following important facts:

. . . **Gas wells** were shown to cost more than oil wells, even in the same depth ranges and in similar locations. And gas wells tend to be almost 50% deeper than oil wells, further increasing their relative cost.

. . . **Offshore** wells completed declined slightly from 1956 but footage increased by about 3½%. And expenditures dropped about 8% to $182,400,000.

Increased efficiency—the product of improved technology and know-how—made possible the significant progress in both per-well and per-foot cost reductions. Costs were cut in the face of much higher prices for all types of drilling equipment.

Two other factors also helped to reduce costs. An increased proportion of offshore wells in 1959 were field wells as opposed to the more costly wildcats which were drilled in large numbers in the earlier offshore days. And drilling in the more expensive Texas offshore area dropped sharply.

. . . **Incremental cost.** Reductions in extreme depth ranges were also the result of increased efficiency.

Yet, in spite of definite progress, as wells go deeper into the earth drilling costs tend to increase geometrically.

Regional trends . . . The study of expenditures also confirmed shifts in drilling between states and regions that have been pointed up in completions and footage statistics.

In 1956, almost 85% of total U. S. drilling expenditures were made in these six states: Texas 35.7%, Louisiana 23.1%, Oklahoma 9.9%, California 6.8%, Kansas 4.6%, and New Mexico 4.4%.

In 1959, these same states accounted for slightly less than 80% of expenditures: Texas 33.2%, Louisiana 24.2%, Oklahoma 8.5%, California 4.8%, Kansas 4.1%, and New Mexico 4.8%. Only Louisiana and New Mexico improved their relative position.

First Round in Area Pricing Is a Draw

• Midland hearing, expected to last more than a week, winds up after only 3 days of argument—and with little accomplished. Two conclusions: Long FPC questionnaire won't be used; cost-of-service data may not be sought.

THREE days of bitter argument suddenly dissolved into a show of complete harmony at the Federal Power Commission's prehearing conference on Permian basin area gas prices in Midland last week.

The conference was called to seek agreement on what sort of evidence is to be presented at the formal hearing, number of witnesses, order of appearance, and agreements on stipulations and joint presentations.

It didn't accomplish any of that. But it did clear a lot of atmosphere.

The conference recessed to April 12 in Washington when a small group will confer informally on the once-controversial subject of questionnaires. By that time, presumably, FPC will have ruled on a motion to exclude cost-of-service testimony. Later the big conference will be called back to continue work on its original purpose.

Mystery . . . The "great questionnaire mystery" dominated the Midland conference.

Producers opened the meeting by saying FPC staff had tossed a bombshell into the works by sending out, the preceding week, a horrendously big questionnaire. It would take big companies a full year with all staff doing nothing else to comply, and small producers couldn't get beyond page one.

Worse, it asked data that could be used to make a cost-of-service rate-based formula. Was the FPC staff reviving the utility concept after the commission had abandoned it? Was staff preparing a case for consumer intervenors?

For 3 days staff sat mum. Then Chief Counsel John C. Mason tossed his bombshell. Staff is not going to send any questionnaire to anybody. It is not going to introduce any evidence. It does not want cost-of-service data in an area-price hearing.

Staff was just trying to be helpful. Its questionnaire was just to start discussion of what sort of information might be useful if readily obtained. The only objective is to help FPC get what it needs in a uniform and meaningful form that might go into the record without need for verification and cross examination.

Meanwhile it came out, bit by bit, that about 50 big companies have sent out their own questionnaire to some selected producers but they wouldn't let anybody see it.

Finally it turned out that the industry questionnaire also asks cost-of-service data but, it was explained, this is just in case it's needed for rebuttal. And the reason for secrecy is that the questionnaire really doesn't exist yet. There is just the first part of a tentative form circulated for comments.

So, after Mason disowned the staff questionnaire, the big producers passed around copies of theirs and offered to sit down in Washington April 12 with staff intervenors, pipelines, small producers, and anyone else interested and work out a method of getting together whatever anyone thinks he needs if it's not too hard to get.

Motion filed . . . The cost-of-service issue also built up to a climax and then almost faded away.

About a dozen majors — but, significantly, not all of them—plus another dozen smaller producers joined in a motion asking FPC to order that cost-of-service evidence not be admitted to the area-price hearing except by certain parties in special circumstances. They asked staff to join.

Mason said he wouldn't decide until he has studied the motion for technicalities, but that anyone who can read should know that FPC has asked for cost data other than the cost-of-service type, and that staff understands that as well as producers.

Spokesmen for consumer and distributor interests seemed flabbergasted by the sudden show of a cooperative spirit as the conference neared adjournment.

They announced that they will oppose the motion to exclude cost-of-service evidence and demand to know what is meant by "other meaningful cost data." But they agreed to show up April 12 prepared to cooperate in a common data-digging venture.

Industry Positions

As the conference progressed it became apparent that producers were dividing themselves more or less loosely into four groups—two groups of major companies and two groups of small independents.

The majors divided into what came to be called the "Merrill group" and the "Orn group" because of the first spokesman for each position.

Merrill group . . . These companies are willing to go along with FPC in gathering cost-of-service data on an industry-wide basis, even though they object to its use and consider it unworkable.

Several have completed their own rate cases based on other types of evidence but are still willing to try to get and apply a cost-of-service study.

First spokesman was William J. Merrill, attorney for Humble Oil & Refining Co. He said he was authorized to speak also for Pure, Phillips, Sinclair, Pan American, Continental, Sohio, Standard of Texas, Skelly, and Cities Service, though each of these reserved the right to make minor variations.

Later his position was generally endorsed by Atlantic Refining, British-American, Sunray Mid-Continent, and others.

Orn group . . . Clayton Orn, attorney for Ohio Oil Co., insisted that FPC delineate the issues before the hearing starts, most specifically by repeating its statement in the Phillips decision that the cost-of-service formula is inappropriate.

Orn was joined by Texaco Inc., Texaco - Seaboard, Socony - Mobil, Gulf, and Shell. Later, Superior, Union Oil, Amerada, and Tidewater endorsed the same stand.

The cleavage between the two groups appeared to become less sharp as the conference progressed.

Respondent independents . . . Small producers who are parties to the area price case and who have rate schedules at issue expressed a willingness to join others in group presentation of testimony, but they reserved the right to submit additional testimony.

Other independents . . . Small producers not parties to the case but with production in the Permian basin which would be affected demanded that their financial needs be considered but said they could not afford individual appearances.

They requested that their trade associations be made intervenors to speak for them and for small producers as a class.

Consumer testimony . . . The public service commissions of Wisconsin and California and groups of cities and local distributors in California, Minnesota, and Iowa said that they will oppose any increased prices in the Permian basin.

They maintained that present ceilings are excessive and the only test of just and reasonable prices is the utility rate-base formula.

An exception was Consolidated Edison Co. of New York, which said it would not associate with other distributor groups, does not advocate any particular theory of regulating prices, favors any expeditious way of being assured adequate supplies of gas at fair and stable prices, feels that most problems have been solved by eliminating spiral escallation clauses, and favors elimination of different prices for old and new gas.

Sun Oil Co. . . . A lone wolf among producers is Sun Oil Co. Attorney John A. Ward III said Sun will not authorize anyone to speak for it and reserves the right to challenge the validity of the area-pricing approach.

He said the law requires regulation on the basis of individual companies only and that Sun's own rate case is nearly completed and it covers everything that would apply to Sun in the Permian basin hearing.

Sidelights From the Hearing

Midland's 450-seat Municipal Theater had standing room only when the conference opened. It was admitted later that scores of small producers had been dragooned from all over West Texas to demonstrate that all gas isn't produced by just a few big corporations.

Chief Examiner Edward B. Marsh, who thought the questionnaire problem could be disposed of during the first hour, interrupted the argument a dozen times with pleas to start cooperating toward group stipulations and presentations. At the conclusion he remarked that the main purposes of the conference hadn't been touched on but perhaps the ice had been broken.

Public-relations men were horrified at booboos pulled by attorneys for some major companies. They asked that the conference go off the record, suggested groups of private caucuses in smoke-filled hotel rooms.

The attorneys did their best to adhere to strict procedural formalities, but the West Texas audience loudly applauded whenever they heard anything they liked. The examiner was visibly astonished, but consumer attorneys were openly annoyed. One suggested the use of applause meters to weigh the validity of evidence in future FPC hearings.

FPC Chairman Jerome K. Kuykendall attended the opening session and called the area-pricing conference a "noble experiment" and "the last best hope" for workable regulation. Then, without naming names, he teed off against obstructionists who have hamstrung and frustrated FPC for years. He asked participants to forget technicalities and make a sincere effort to make area pricing successful. Commissioner Arthur Kline was a close observer through the conference but took no part in it.

Coal got in its innings at the Midland conference. Counsel John McGrath of Fuels Research Council, Inc., worked both sides of the street. First he said producers should get a higher price and that Wisconsin has so much cheap gas running out of its ears that it is shoving all other fuels out of the market. Then he put in a plug for end-use controls by saying that gas is a fast-diminishing resource and should be reserved for higher uses.

It looked like only common courtesy when small producers began thanking FPC for holding the Permian basin hearing in the Permian basin. But the fat was in the fire when the spokesmen for the northern distributors group said the next hearing should be in Minneapolis so FPC can understand consumers' problems.

Then California got in the act with an invitation, and the place of the next hearing became a major issue. Finally staff counsel explained that FPC must hold major hearings in Washington but that some parts of area-pricing hearings will be held in the areas concerned.

Major Questions

The size and detail of the staff questionnaire got far more discussion than any other topic. Many minor questions were raised about future procedure, but the major subjects getting attention were these:

. . . Delineation of issues. Most said that since FPC started this new method it should specify just what sort of evidence it will consider—or at the very least what it doesn't want.

The FPC staff appeared to take the position that the door is open to producers to do anything they want, but to be safe they had better put in every type of evidence they can scrape together.

. . . Cost - of - service. Most consumer interests insisted that the individual cost - of - service rate - base formula is the only legal and proper way to regulate.

The "Orn group" insisted that

ATTENTIVE GAS MEN sat through 3 days of testimony at Midland. Vacant seats show here only because photograph was made just after a recess and all participants hadn't yet returned to the auditorium. Next meeting will be April 12 in Washington.

in the Phillips decision FPC said cost-of-service is not proper and it should now instruct its staff to exclude all cost-of-service evidence and to revise the questionnaire so that it cannot be used to compute a rate base later.

The "Merrill group" appeared willing to submit cost - of - service data if required—though considering it useless—but preferred to do so on an area rather than an individual-company basis. But they want to be spared the trouble if such data is not to be used. Many companies said they do not intend to present cost-of-service studies but reserve the right to do so if it appears FPC is going to go back to that method.

. . . Other cost data. Producers said they intend to rest their cases largely on industry-wide cost data—not the cost-of-service type—which will show financial requirements of the industry. But they want FPC to be more specific than in its policy statement as to what form of economic evidence it prefers.

On the other hand, the staff criticized producers for not being more specific in telling now just what data they will present and indicated that FPC should not say what evidence is sufficient until it has received the evidence.

. . . Area concept. Small producers welcomed the new area pricing approach as practical and promising. The majors seemed less enthusiastic but—except for Sun—were willing to try to make it work.

Consumer spokesmen maintained that area pricing is illegal, unworkable, and will settle nothing; that FPC's present ceilings are arbitrary and indefensible in court; and that area pricing is a one-way street whereby low-cost producers get a windfall up to the ceiling price but high-cost producers can ask for rates above the ceiling.

Another question is whether the evidence should be area-wide or nation-wide. The majors said that in compiling joint data they will have to use company-wide figures and industry-wide trends of supply and demand, costs, and financial requirements. Small producers said they can furnish only area data.

. . . Burden of proof. Examiner Marsh said the present FPC ceilings should be considered reasonable and anyone wishing to change it in either direction should have the affirmative burden of proof.

Consumer spokesmen said the ceiling price is meaningless and that each producer has the burden of proving that his present prices, even if way below ceiling, are just and reasonable.

Sun said that contract prices must be considered reasonable and need no affirmative proof, and that the burden of proof rests on anyone who challenges a contract price.

The position of most producers seemed to be that they are willing to demonstrate what prices are just and reasonable without necessarily starting with either contract or ceiling prices—provided FPC will accept their method of proof.

. . . Small producers. Consumer interests urged arbitrary elimination from the hearing of all producers with sales below some annual figure, saying they would be satisfied with close regulation of the dozen or two majors that supply 90% of their gas.

But the small producers said that their sales are not inconsequential to them, and they insisted on being heard.

. . . Savings clause. All producers asked for a clause whereby if they join in a group presentation they will not be foreclosed from putting on additional individual testimony.

. . . Dual prices. Everybody except some consumer interests criticized the present FPC ceilings for having one price for new contracts and a lower price for old contracts. Evidently there will be much testimony to show this is unjustified and discriminatory. One producer said that FPC has indicated that the dual system was only temporary and it is now time for FPC to say how long it is to continue.

Operators of gas-processing plants, particularly, propose to submit a special presentation showing of dual prices are already forcing duplication of facilities, since new plants are being built to pay the higher price for casing-head gas while old plants bound by the lower price are running below capacity.

Get Ready for a Record Surplus of Gasoline!

THE dizzy height of gasoline stocks clearly shows it's time to blow the whistle on high refinery runs.

Gasoline stocks at the end of February were nearly as high as they were last year at the end of March. And the March inventory last year was out of line.

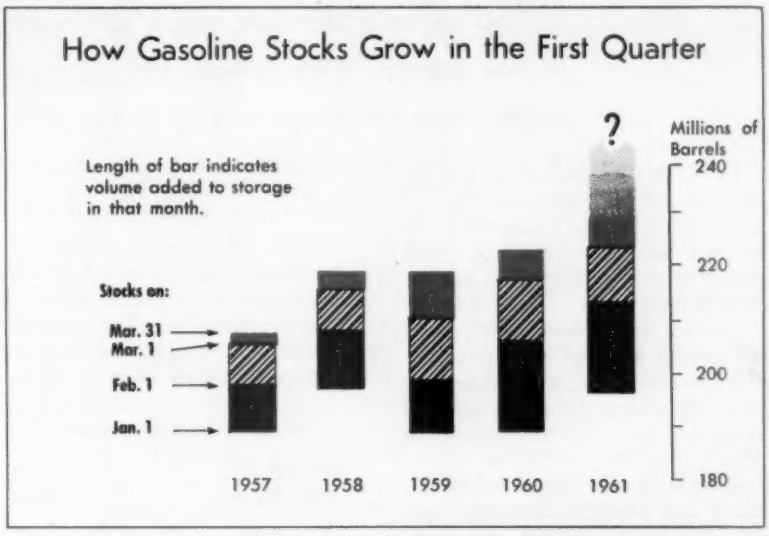
With stocks out of joint already, they're bound to get worse, because normally March is a month when gasoline stocks rise just prior to opening of the motoring season.

The current picture: Gasoline stocks at 221 million barrels at the end of February. They were 222.7 million barrels at the end of March last year.

Compare this with a desired level of 200 million barrels of gasoline on hand at the end of March. That is the average of "desired level" estimates reported to the Texas Railroad Commission a year ago.

This means that current gasoline stocks are 21 million barrels above desired levels with a month to go. Over the past 6 years stocks have risen an average of 4 million barrels in March. But the March increase last year was 5.6 million barrels, and in 1959 it was 8.2 million.

Why worry? Why not just hold the stocks until motoring demand perks up?



Danger in this is that a single refiner with excessive gasoline inventories at the start of the season may be attracted into cutting his price to make some spot sales. He may have lowered his own surplus a bit, but he has not reduced the industry's surplus, and he has drawn a perfect diagram for a season of soft gasoline markets.

The answer seems to be for refiners to tailor runs to expected demand. Especially is this vital on the Gulf and East coasts, because stocks there are particularly excessive.

The proof: Total stocks at the end of February this year were 3.5 million barrels greater than for the same time last year, but volumes held on the Gulf and East Coast were 8 million barrels greater. This means that stocks in other areas actually were down.

Shell Joins Dallas-Fort Worth Market Fight

ONE of the most fiercely competitive gasoline markets in the country—the Dallas-Fort Worth metropolitan area—is getting even tougher.

This month Shell Oil Co. starts negotiating leases for new service stations in the two cities. The first Shell station in the area's history probably will be open sometime this spring.

Before it is finished, Shell expects to be firmly established as a major factor in Dallas-Fort Worth gasoline marketing with roughly 100 new stations in Dallas and another 50 in Fort Worth.

The company's invasion of Dallas-Fort Worth and North Texas generally is being directed from a new district-marketing headquarters opened in Dallas last October. The district, under manager W. J. Harrell, takes in all of Texas except the Gulf Coast region from Austin and San Antonio to the south.

Shell made its first move in North Texas last month when it appointed Young Oil Co. as area distributor in Collin County, north of Dallas. Young Oil, former distributor for Continental Oil Co., owns 14 stations.

Shell plans to build stations only in Dallas and Fort Worth. It will look for jobber arrangements in the rest of the district.

Signs indicate that Shell won't be the last major oil firm to join battle for the snowballing gasoline market in Dallas-Fort Worth.

Heavy postwar increases in population show no signs of tapering off.

Established major marketers—including Humble, Mobil, Texaco, Gulf, Sinclair, Phillips, and Conoco—have built stations feverishly during the past decade.

Independents such as American Petrofina Co. of Texas are giving the majors a strong run for their money in the competition for good station locations. And independent gasoline-retailing chains are just as active.

Among signs that more majors may join the struggle:

About a year ago Standard Oil Co. (Ind.) bought out a Dallas jobber, American Oil Co., and reportedly has been surveying the area.

And Dallas marketers are spreading the rumor that Standard Oil Co. of Texas also may become one of their competitors.

Residual Fuel Imports Will Be Based on

• Gap between domestic supply and total demand will be filled by residual fuel-oil imports. New Interior plan puts allocations on an annual basis and makes room for newcomers by slicing 15% from historical importers.

CONTROLS of residual fuel-oil imports will be continued, but the new plan announced last week by Interior Secretary Stewart L. Udall makes major revisions in current procedures.

Interior is abandoning the pretext of keeping residual imports at the 1957 level. Instead, it will now base total allocations on supply-demand estimates made by the Bureau of Mines.

That is, it will estimate total demand and available domestic supply, then permit enough imports to fill the gap.

By this means, Interior hopes to avoid the readjustments in quotas that were frequently made during a given allocation period under the old program.

Also, allocations will be on an annual basis, rather than quarterly. However, the rules provide that imports during any quarter of a yearly allocation period will be restricted to a percentage specified for that quarter. This is to prevent a flood of imports during any quarter.

And newcomers will be permitted into the program. But on a basis that differs in several respects from the newcomer plan adopted by the Eisenhower administration just before it went out of office.

New import level . . . For the year beginning April 1, Interior has set total allocations for District 1 (East Coast) importers at 461,427 bbl. daily.

That is almost 120,000 bbl. daily above the District 1-4 average of 343,000 bbl. daily in 1957. And it is almost 40,000 bbl. daily above actual resid imports in 1960.

Importers of residual fuel oil in 1957 will get quotas based on 85% of the ratio of their imports to total imports in that year, multiplied by the amount of oil available in the upcoming period.

The impact of this action on historical importers to provide room for newcomers is greatly lessened, however, by the increase in the total level of resid for the year beginning April 1.

Actually, under the new plan, historical importers will be able to bring in considerably more than they did in 1957, but a little less than they averaged in 1960.

(Each year after, the new rules provide, the 85% figure will be reduced three points annually, so historical importers will gradually lose their advantage over newcomers.)

Newcomers . . . The total to be divided among newcomers for the upcoming period will be the 15% taken from historical importers.

To be eligible, a newcomer must have management and operational control over terminals capable of receiving tankers. And the input must be residual fuel oil he owns.

This is a basic change from the January 19 regulation which did not require control of a terminal nor ownership of the fuel.

The size of the quota for the individual newcomer will be based on the input of residual fuel he owns into deep-water terminals. Also, a sliding scale will be applied. Thus, as the volume of inputs increases, the percentage factor used in determining the quota declines. The purpose of this is to give a break to the smaller importers.

For some large companies, such as Gulf Oil Corp., the sliding scale will mean a smaller quota than the firm would have gotten under the newcomer provisions adopted by the Eisenhower administration.

The new rules also eliminate the "double counting" of input that would have been permitted under the regulation adopted January 19.

Under the January provision, residual fuel could be counted for quota purposes each time it entered a terminal. Therefore, transfer of the same oil from one deep-water terminal to another would have counted more than once.

Under the rules now adopted, only the original input will be counted in determining quota eligibility.

"New" newcomers . . . Last week's plan also makes room for a company to become eligible for an import quota during the upcoming allocation year even though he is not eligible at the start of the allocation period.

He may become eligible, beginning October 1 of this year, if he had terminal inputs into a deep-water terminal in District 1 if the terminal was under his management and operation control after April 1 of this year.

To make room for these "new" newcomers, Interior will withhold from current allocation approximately 2% of the total available for the year beginning April 1. If all this amount is not used, it will be distributed to those already in the program.

Districts 2-4 . . . In these districts, allocations will still be based on 1957 levels rather than on supply-demand estimates as in District 1.

However, the Secretary of Interior is given the authority to make

How new quotas are set

THE NEW residual fuel-oil import rules for District 1 set up a sliding scale for quotas for newcomers, based on their deep-water terminal inputs for the year which ended September 30, 1960.

The sliding scale follows:

Average bbl. daily input	% of input
0- 1,000	100
1- 5,000	41
5-10,000	29
10-30,000	16
30,000 plus	10

Total Demand

adjustments in these allocations. Some announcement affecting Districts 2-4 is expected to be made by Interior soon.

There is no provision for newcomers in these districts. Thus allocations will be made only to importers of record during 1957.

Gasoline-Tax Hearing To Begin This Week Before House Group

ONCE again the American petroleum industry is going to Congress to ask it to let a "temporary" gasoline tax die as scheduled on June 30.

The industry's chief spokesman is to be John Swearingen, president of Standard Oil Co. (Ind.) speaking for the American Petroleum Institute.

He will speak also for Western Oil and Gas Association, Mid-Continent Oil and Gas Association, and other associations and companies.

Swearingen will be one of 50 or more witnesses due to testify on highway financing problems in week-long hearings starting March 14 before the House ways and means committee.

Focus of the hearing is President Kennedy's proposal to continue the current 4-cent a gallon rate "indefinitely" and to collect more from truckers by boosting diesel-oil taxes to 7 cents a gallon, tire, inner tube and tread rubber taxes to 10 cents a pound, and by higher use taxes for big trucks.

Under present law the 4-cent tax is to drop to 3 cents on June 30 and part of the excise tax on automobiles and auto parts is to go into the highway trust fund to replace the gas-tax revenue.

Secretary of the Treasury C. Douglas Dillon is down as the first witness, followed by David E. Bell, budget bureau director, Secretary of Commerce Luther Hodges and Federal Highway Administrator Rex M. Whitten. They will back up the President's plea.

watching WASHINGTON

Clyde La Motte

• Action on FPC appointments still hangs fire . . .

IT MAY be some time yet before the industry finds out who is going to be the next chairman of the Federal Power Commission.

Back in January, President Kennedy announced his selection of Joseph C. Swidler, a former attorney for the Tennessee Valley Authority, to head the agency. And Howard Morgan, a politically active Oregon rancher, was named to fill another spot on the commission.

Thus far, neither name has been sent to the Senate for confirmation. As far as the senators are concerned, all they know about the appointments is what they have read in the papers.

Even when the White House decides to send the names up to Capitol Hill, there is no guarantee at all that either the Senate committee or the Senate as a whole will be in the mood to act in a hurry. Rather, the Senate may see fit to move as slowly on the appointments as has the Administration. So weeks, if not months, may slip by before any final action is taken.

This sort of delay simply means that natural-gas producers will be kept in doubt that much longer on major policies that must be shaped up if there is ever to be any real headway in whittling down the backlog of cases at the FPC.

• Strong opposition to Swidler has developed . . .

THE LACK of action on the FPC appointments is a clear tipoff of a behind-the-scenes struggle over the appointments, particularly that of Swidler.

Some strong opposition to Swidler has cropped up in industry circles and in Congress. The Administration, keenly aware of this, is moving cautiously. It does not want to send the names to the Senate unless it is sure the appointees will be confirmed, preferably with a minimum of public attack. Of course the Administration has another alternative: Drop Swidler's appointment and select another man for the job.

The first opposition to Swidler came from private utility circles who felt that Swidler, while an attorney with TVA, developed an entirely one-sided viewpoint. For this reason, they felt, he could hardly be unbiased as chairman of the FPC.

Some gas industry officials have become alarmed, too, fearing that Swidler's record and background hardly augured a fair shake for the industry. The more they learned of Swidler, the more they became concerned.

In the Senate, several members have voiced outright opposition to Swidler while others want to look into the matter further.

Obviously, however, no action of any kind can be taken until Swidler's name is sent up for confirmation.

• Some say Swidler will never be seated, but . . .

SOME "insiders" in Washington are predicting that Swidler's nomination will never be approved. But that attitude may be based more on wishful thinking than any concrete development.

What appears more likely is that Swidler's name will be sent up and, after some delay and a little oratory, the Senate will confirm his nomination.

Morgan's appointment probably will be approved in routine fashion, once the Swidler nomination is settled.

Big New LPG Line in Midwest Planned

LPG's spectacular career will take another big step forward when a new 800-mile pipeline system from Central Kansas to the St. Paul-Minneapolis and Central Illinois areas becomes a reality.

Northern Gas Products Co., a wholly owned subsidiary of Northern Natural Gas Co., and Great Lakes Pipe Line Co. will operate the system.

Northern Gas Products will build a 350-mile 8-in. pipeline from its new extraction plant at Bushton, Kans., to Des Moines, Iowa, where it will connect with Great Lakes.

Great Lakes will convert two 6-in. pipelines, now used for products, to handle liquefied petroleum gas. One line extends north from Des Moines about 200 miles to the Twin Cities area. The other extends almost directly east, about 250 miles, to the Chicago area.

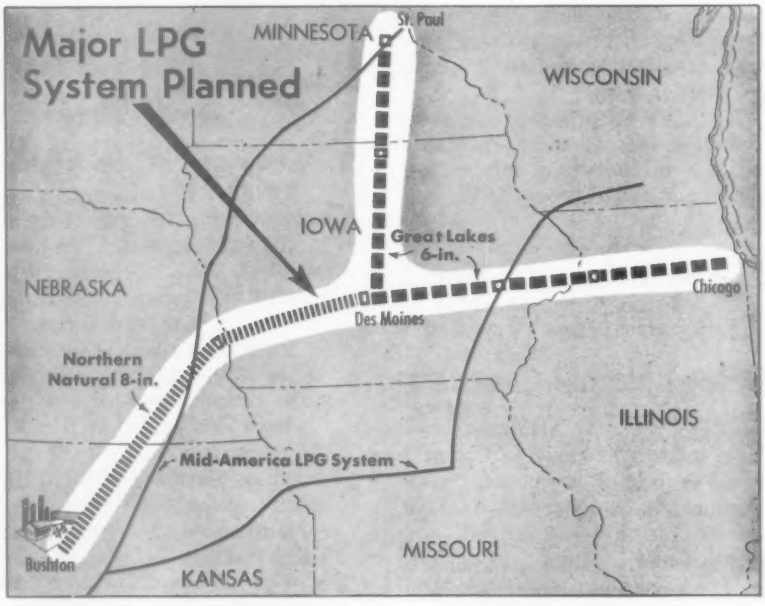
The system will have a capacity of 40,000 bbl. per day. It will have seven terminals—three on the Northern Gas section and four on the Great Lakes section—all owned by Northern Gas Products.

Terminals on the 8-in. line will be at Bushton, Kans., at Plattsmouth, Neb., about 12 miles south of Omaha, and at Des Moines. Terminals on the Great Lakes northern leg will be at Iowa City, Iowa, and at Rosemount, Minn., 15 miles southeast of Minneapolis, and on the eastern leg at Mason City, Iowa, and Prophetstown, Ill., about 30 miles northwest of the Davenport-Moline area.

The projected system closely parallels the northern portion of the Mid-America Pipeline Co. system, the country's first major pipeline built to handle LPG. Mid-America only started operating this winter.

The Mid-America line originates in the Permian basin of West Texas-New Mexico and splits at McPherson, Kans. From McPherson one leg goes north to Minneapolis and the other northeast to Janesville, Wis., just south of Madison.

Bushton, origin of the Northern Gas line, and McPherson, divide point on Mid-America, are only 40 miles apart. The systems will cross in southern Nebraska and again near Cedar Rapids, Iowa, where the eastbound leg of Northern Gas-Great Lakes and the northeast leg of Mid-America meet.



Announcements of the new system were made last week by Great Lakes and Northern Natural after agreements were signed. The announcements did not disclose when the line from Bushton to Des Moines will be built nor when the whole system is expected to be in operation. Northern's disclosure said the Bushton-Des Moines line will cost $12,000,000.

Initial source of products for the new system will be the huge extraction plant Northern Gas Products is building at Bushton. This will be one of the world's largest extraction plants.

Northern's principal sources of gas are the Kansas and Oklahoma Hugoton fields and the Permian basin fields of West Texas and New Mexico. The plant that will process this gas will cost $12,000,000. Its products will include propane, butane, isobutane, ethane, and natural gasoline.

Companies which own Great Lakes and, therefore, will have an interest in the new system are Continental, 29.8%; D-X Sunray, 18.96%; Skelly, 12.22%; Texaco, 12.14%; Pure, 9.48%; Sinclair, 5.88%; Phillips, 4.99%, and Cities Service, 5.15%.

Phillip A. Gass, senior vice president of Northern Natural, is president of Northern Gas Products Co.

Northern's action follows two recent major steps it has taken to strengthen its position. One was the absorption of the Permian Basin Pipeline Co. and the other was the purchase of 16% of the stock of Transwestern Pipe Line Co. which, last year, completed a gas line to California.

Northern Natural got into the propane business last year when it organized the Northern Propane Gas Co. This subsidiary's role is to market propane in the northern plains areas which cannot be economically served by natural-gas pipelines.

The apparent duplication between Mid-America and the Northern Gas-Great Lakes facilities has a counterpart in twin propositions to build LPG lines from Texas to North Carolina.

Trans-Southern Pipeline Corp., a Transcontinental Gas Pipe Line Corp. subsidiary, and Dixie LPG Pipeline Co.—backed by Warren, Phillips, Union Texas and Tuloma—both declare they will build lines from Mount Belvieu, Tex., to points in North Carolina.

The big question in both instances is whether there is enough market to warrant competing lines.

THERE'S A BIT OF SALT IN THE WIND

STUPP CORPORATION

MANUFACTURERS OF CUSTOM STEEL LINE PIPE
FOR THE OIL AND GAS INDUSTRY

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TGT, Pemex Draft Final Pipeline Contract

- Texas-Mexico-California gas line now believed ahead of rival groups seeking to block its entry into rich Los Angeles market.

TENNESSEE Gas Transmission Co. and Petroleos Mexicanos last week worked on final wording of contracts for the Texas - Mexico - California gas pipeline.

Included in the deal is a $15 million prepayment to Pemex for a separate gas pipeline to serve Monterrey.

Drafting of the contracts apparently scotched efforts of some industrial groups and a rival company to halt construction plans for the line.

Tennessee Gas and Pemex earlier had negotiated agreements on the line, and these were being formalized last week by W. W. Witmer, senior vice president of Tennessee Gas, and Pascual Gutierrez Roldan, Pemex director.

More hurdles . . . Still to be approved, however, are applications by Tennessee Gas before the California Public Utilities Commission and the Federal Power Commission.

These applications involve construction rights in California, export and import licenses for gas moving out of Texas and into California, and possibly rate regulation.

The $15 million prepayment to Pemex, which had been written into the original agreement but not generally publicized, was designed to satisfy industrial interests at Monterrey who feared the loss of Mexican gas supply by export. Gas from the Reynosa area will be taken by the TGT-Pemex line.

The money will be used to construct a line from the Poza Rica fields in the Tampico area northward to Monterrey. The city currently gets gas via a 12-in. line from Reynosa, also the source of Mexican gas being dedicated to the Tennessee Gas-Pemex line.

Witmer said he believes that Monterrey interests which had opposed the international line will be more than satisfied with the new arrangement. They will be tied in with a gas reserve estimated at 3 trillion cubic feet.

Rival plan . . . The bid of a rival pipeline company, International Gas Co., to build a gas line to California using Mexican gas exclusively was described as "economically impracticable" by Gutierrez Roldan.

The Pemex director said the proposal to take Reynosa gas to California by way of Mazatlan on the western Mexican coast could not pay out. He said plans are being made by Pemex itself to provide a natural-gas distribution system for Mexican cities on the west coast.

International Gas, which has headquarters in Los Angeles, is the firm proposing a rival plan calling for a 1,480-mile $159 million line using Reynosa gas. The company, a newcomer to the pipeline business, is headed by Thomas W. Evans, board chairman, and C. C. Dawson, president, both of Los Angeles. E. Van Dornick, Los Angeles, is vice president; and Miles Carmichael and D. W. Cameron, both of Tulsa, have a connection with the company.

Tennessee Gas has established two Mexican affiliates for its operation. Propulsora Internacional, S. A. de C. V., would act as purchaser of gas from Pemex; and Supervision y Servicio, S. A. de C. V., would operate the 34-in. 1,200-mile section of the line across northern Mexico.

Tennessee Gas has established Texas and California subsidiaries to build and operate the U. S. sections of the $165-million line. Humble Oil & Refining Co. will furnish the bulk of the gas from its King Ranch reserves in South Texas, and Southern California Edison will be the chief customer in California.

Construction of the line will require about 10 months after necessary approvals are granted.

Rock Springs case . . . The California Public Utilities Commission, meanwhile, has been asked to reopen the Rock Springs natural gas pipeline proceedings and consolidate them with the upcoming hearing on the Texas-Mexico-California line.

California Gas Transmission Co., the Los Angeles-based subsidiary of TGT, filed the motion.

The Rock Springs project is a joint proposal of El Paso Natural Gas Co. and Colorado Interstate Gas Co. to deliver gas at the Nevada-California line near Las Vegas to Southern California Gas Co. and Southern Counties Gas Co.

Both projects ultimately depend on Southern California Edison Co. as the principal customer. Edison, however, is backing the Texas-Mexico-California project.

The request of California Gas Transmission asked that the commission hear comparative data on the rival projects.

Union Oil Chief Calls Diversifying Key to Survival

DUDLEY TOWER, president of Union Oil Co., says the one thing certain about today's oil business is that it's changing and to keep abreast a company must diversify.

As an indication of what he

INDUSTRY

A 10-year old antitrust suit against Texaco has been dismissed in U. S. District Court in Los Angeles. Texaco and six other West Coast majors were named in the conspiracy case when it was filed in 1950. The six other companies signed a consent decree in 1959, but Texaco refused to sign. In commenting on the dismissal, Texaco said it felt a full trial would have ended in "complete exoneration" and that the dismissal indicates the Government feels the same way.

Two more sextuple completions have been approved by the Texas Railroad Commission. They are Sunray Mid-Continent's 20 McFadden "E" producing from one oil and five gas zones in McFadden field, Victoria County, and Humble's 167

means, Tower says Union is looking at petrochemicals, plastics, exotic fuels, and "in a minor way" at some fields not related to oil.

"The oil industry of the future will not be like the oil industry of the past," he told a Pacific District meeting of the Petroleum Equipment Suppliers Association.

The Union president told the equipment men they too should diversify and broaden their sales programs to offer oil companies of the future whatever they need.

Too much oil . . . The present oversupply of oil is expected to last for several years, but Tower sees a big long-range demand for oil.

The U. S. is expected to supply much of this demand, but the country's role in world production is growing smaller.

Tower said many of the sedimentary basins in California, Illinois, Kansas, and Oklahoma, have been worked over and offer little for the oil explorer.

California, he said, "is through as a growth area for exploration" although some new oil and gas will be found.

The state's production has declined from an all-time high in 1953 of 1,000,000 bbl. daily to the present level of about 830,000 bbl. daily.

Transwestern Buys Phillips Gas

• Three-way deal gives Phillips cash for reserves, lets Transwestern pay the banker as it takes the production.

TRANSWESTERN Pipeline Co. has acquired a big new gas supply in the Oklahoma and Texas panhandle areas.

Phillips Petroleum Co. has sold its developed gas reserves in a six-county area to New York banking interests, which in turn will sell the gas as it is produced to Transwestern.

Phillips sold its reserves for $27 million in cash to First Transportation Gas Corp., a wholly owned subsidiary of Eastman Dillon Union Securities & Co. First Transportation is selling the gas to Transwestern for a wellhead price of 17 cents an M.c.f.

Involved in the sale were 67 gas wells on 23,000 acres in Beaver, Woodward, Harper, and Ellis counties of Oklahoma and Lipscomb and Ochiltree counties in Texas. Reserves were not disclosed. Phillips' interest in the wells ranged from 100% down to one-sixteenth.

In dealing with a third company, Phillips was able to get cash for its properties, and Transwestern was able to get reserves without a large capital outlay.

A Transwestern spokesman in Houston said Transwestern has no connection with First Transportation except that "they are the producers, and we are buying from them."

First Transportation is not expected to develop the acreage further, but there is a likelihood that if Phillips develops other nearby acreage the production will be sold to First Transportation under the same kind of arrangement.

Green County Crude Raised

A PRICE increase of 15 cents per barrel has been posted by Ashland Oil & Transportation Co. for crude from all leases connected to its pipeline system in Greensburg, Green County area of Central Kentucky. New price is $2.80 per barrel.

Leases affected currently are producing about 4,300 bbl. daily. The increase does not apply to crude delivered into Ashland's pipeline system by truck.

BRIEFS . . .

King Ranch - Borregos, a sextuple oiler in Borregos field, Kleberg County.

A data - processing center is planned by Shell Oil at Menlo Park, Calif., south of San Francisco. At first the center will handle only marketing-department work. It is scheduled to open in early 1962.

First of 55 celebrations planned in honor of Sun Oil's 75th anniversary was held in Tulsa last week. Robert G. Dunlop, Sun president, and Jno. G. Pew, senior vice president, addressed the Tulsa dinner gathering. The two officers will attend all of the employe anniversary meetings, which are scheduled through late October in the U. S. and Canada.

Canadian Devonian Petroleums shareholders will meet March 27 to consider an offer of almost $17 million made for the company by British American. The BA proposal amounts to $4.95 a share for 3,429,-664 shares of common stock outstanding.

Big Chief Drilling Co., Oklahoma City, has taken over management of Seneca Oil Co., a small independent. Seneca will have access to the staff of Big Chief, which maintains exploration and production departments in addition to its drilling activities.

Consolidation of drilling operations of Tradewinds Exploration, Inc., Tulsa, into a subsidiary called Tradewinds Drilling Co. has been announced. The move combines two former Tradewinds subsidiaries, Roden & McRae Drilling Co. and Warren-Bradshaw Drilling Co., both of which have been contract drillers in the Mid-Continent and Rocky Mountain areas for 25 years. Tradewinds Drilling will operate 16 rotary rigs in these areas.

Record $33.6 million budget for drilling - exploration and expansion of gas transmission and distribution systems has been set up for 1961 by Lone Star Gas Co. About $10.9 million is allocated for exploration and drilling and the rest for pipeline work.

Transfer of 91 wells in the Reed City field of Osceola County, Michigan, from Ohio Oil Co. to the Michigan Consolidated Gas Co. is one of the first major moves in the gas company's long-range plan to convert the 5,300-acre oil field into a gas-storage reservoir.

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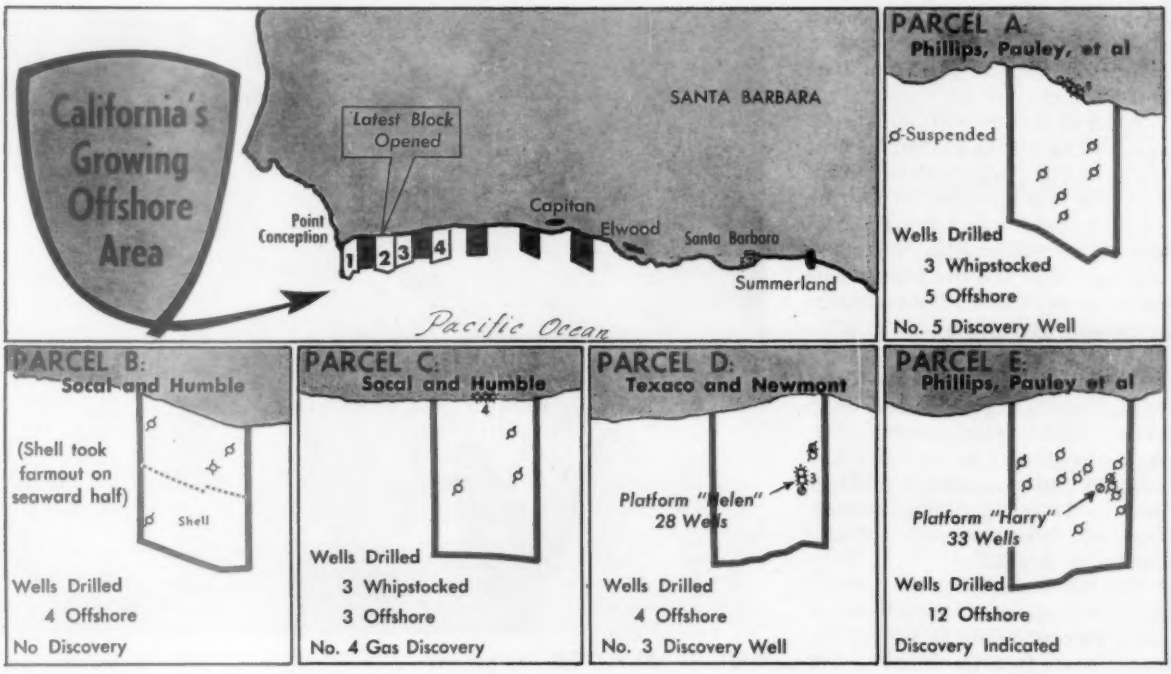

Interest Grows in California Tidelands

Carl J. Lawrence
West Coast Editor

A NEW producing province is shaping up in the deep waters off Santa Barbara County, California.

This new producing area is spotted along 26 miles of coastline running east from Point Conception. Thirty-four wells have been drilled in the area since it was opened to leasing in mid-1958.

These 34 holes have turned up three gas discoveries, one probable discovery, and plenty of speculation about what kind of field or fields may develop. Interest is expected to remain high since the state has just started leasing new acreage there.

Texaco Inc. was the apparent high bidder last week when bids were opened on a 4,250-acre tract known as Block 2. The tract is adjacent to Parcel E, where Phillips Petroleum Co., Pauley Petroleum Co. et al. spudded their first test early this month from a 33-well permanent platform (OGJ, Feb. 27, p. 76).

Texaco bid $9,550,000 or $2,247 an acre for Block 2.

Despite all the activity and interest off Santa Barbara County, there are still three big questions to be answered about this new producing area:

...Is it primarily a gas or oil province?

...Has a new basin which stretches from the mainland to three islands 25 miles offshore been found, or is the area an extension of the Ventura basin?

...Just how valuable are leases off Santa Barbara?

The three discoveries made in the last year indicate the area primarily is a gas province. Gas discoveries have been confirmed on Parcel A, a Phillips-Pauley block; on Parcel C, owned by Standard Oil Co. of California and Humble Oil & Refining Co.; and Parcel D, a Texaco-Newmont Oil Co. tract. The probable discovery is on Parcel E.

Parcel B is the only tract where production has not been established or indicated. Four wells have been drilled there, three by Standard of California and Humble and one by Shell Oil Co., which took a farmout on the seaward half of the block. One of the three Socal-Humble wells has been classed as a dry hole. The other wells are plugged and suspended.

One element that muddies the water on the reports of the Santa Barbara wells is the fact that all are tight holes. As an example, Phillips-Pauley's 12 wells in Parcel E are plugged and suspended, but none has been reported either as a producer or dry hole.

And even on the wells reported as discoveries, nothing is released other than the location (and only the surface location on the whipstocked wells) and the total depth.

However, some evidence has been provided to support the theory of a new basin in the making. The discoveries are gas wells with some condensate and this puts them in a different class from the low-gravity oil wells onshore.

Some state officials who have the files on all wells drilled admit the new basin possibility is a live one at this point.

The new wells are believed to be producing from Miocene sands at around 4,500 ft. The same formations produce onshore, leading some geologists to believe the offshore is an extension of onshore producing areas.

Lease sale . . . Bids opened recently

on Block 2 give a good indication of what one operator, Texaco, thinks of prospects off Santa Barbara.

Texaco's $9,550,000 bid was almost $8,000,000 more than the next highest bidder, Richfield Oil Corp. Richfield bid $1,600,015 for the tract. The only other bid was $851,600 by the Phillips-Pauley group.

Texaco was also the highest bidder in a 1958 sale. The company, along with two partners, bid $23,711,538 for Parcel D.

In addition to the bonus bids, Texaco has a big investment in a 28-well mobile platform doing development drilling on Parcel D. The company has completed two gas wells on D and is drilling a third. Two core holes also are reported capable of producing.

The big Texaco bid on Block 2 should run up the price on Block 3, which adjoins Parcel D and will be leased next. Bids for Block 3 will be opened April 7.

The size of the Phillips-Pauley bid came as a mild surprise. The group's platform on Parcel E is within ¼ of a mile of Block 2. The group has drilled 12 wells on E, more hole than any of the other offshore operators. On Parcel A, the group has drilled eight wells, three whipstocked from onshore locations and five from platforms.

There are seven companies who own the big share of the Phillips-Pauley group. They are Phillips, Pauley, Austral Oil Co., Kerr-McGee Oil Industries, Inc., Caulkins Oil Co., Union Texas Natural Gas Co., and Frankfort Oil Co., a division of Joseph E. Seagrams & Co.

Neither Texaco nor Richfield had any partners in their offer. The Texaco bid may be approved April 12.

The other active members of the California offshore play, Standard of California and Humble, failed to submit a bid on the new acreage. And Shell Oil Co., which kicked off the latest leasing flurry by nominating the acreage, didn't bid.

Present drilling . . . Only two wells are making hole off Santa Barbara. These are the Phillips-Pauley well in Parcel E and the Texaco well in Parcel D.

Phillips-Pauley have staked location for another well to be whipstocked under Parcel A, but the well has not been spudded.

NATURAL GAS POWERS a thermoelectric generator which provides cathodic protection for two pipelines of Northern Illinois Gas Co.

Fuel Cell Used on Pipeline

• Ten-watt unit, powered by natural gas, gives cathodic protection to 16-in. gas lines of Northern Illinois.

A FUEL CELL powered by natural gas is getting high marks from engineers of Northern Illinois Gas Co.

The natural-gas device is a 10-watt thermoelectric generator unit which provides cathodic protection from pipeline corrosion. It's believed that this is the first commercial application of this kind of cell.

The unit, custom-made for Northern Illinois by Minnesota Mining and Manufacturing Co., has been field tested for 8 months. Elmer Paver, one of the Northern Illinois engineers, reports the generator has done a perfect job.

In cathodic protection, an externally generated current is used to overcome the natural loss of current from a pipeline and the consequent danger of corrosion.

The new unit, installed in place of a rectifier, delivers 2.9 amp. at 3.3 volts. It uses 1.1 cu. ft. of natural gas per hour.

Current reproduced by the unit has improved cathodic protection on two 16-in. coated gas lines by increasing voltage from 620 to 1,200 mv.

At present, Northern Illinois has about 100 rectifiers in its cathodic-protection system. The annual electric bill for these rectifiers comes to roughly $10,000.

Initial cost of a thermoelectric generator would be $250 to $450 higher than the price of a rectifier, depending on amperage.

The generator appears to be durable, although it hasn't been in service long enough for a conclusive judgment to be made. One of its greatest advantages is the fact that it can be short-circuited without being damaged.

Contingent on temperatures, internal resistance of the unit is about 0.92 to 1.0 ohms and maximum output ranges from 9 to 12 watts.

Top power is attained at the balance point—that is, when load resistance equals internal resistance. At that point, load voltage is ½ of open-circuit voltage and current value is 3 to 3.5 amp.

Length of a pipeline which can be protected by a thermoelectric generator depends on such factors as diameter, coating, and circuit resistance.

Indefinite Gas-Contract Escalations Banned

• FPC changes rules to make such clauses inoperative in contracts filed after April 3. Commission takes view that indefinite escalations merely add to uncertainty on gas prices and expansion of pipeline-company service.

INDEFINITE escalation clauses in future gas-sales contracts made by independent producers have been outlawed by the Federal Power Commission.

The agency amended its rules to make the clauses inoperative in contracts filed after April 3.

The action followed a Pure Oil-El Paso Natural Gas case in which the commission found that indefinite price escalations are contrary to the public interest.

FPC explained in its order that contracts containing indefinite escalations only "contributed to instability and uncertainty" on gas prices and service expansion by pipeline companies.

Commissioner Arthur Kline filed a partial dissent to the new rule. He concurred in the decision which in effect knocks out favored-nation, spiral-escalation, and price-redetermination clauses. However, he opposed eliminating provisions which permit price changes through negotiation or arbitration after a 5-year period.

Kline said a producer should have the right to renegotiate his contract price to protect himself against inflation or other unforeseen contingencies. The producer should not be compelled to agree at the beginning of his contract to a fixed price for the gas 20 to 50 years in the future when conditions may be wholly different, Kline stated.

Kline also objected that the FPC has never published notice of any intention to adopt such a broad rule and that no showing that all the outlawed clauses are against the public interest has been made.

In the rate case, the FPC denied three proposed increases totaling about $98,000 a year by Pure Oil Co. for natural gas sold to El Paso Natural Gas Co. Reason for the denial was the commission's finding that there had been no escalation of Pure's prices by reason of favored-nation provisions in its contracts.

The contracts provided that the price of Pure's gas would be increased to equal any higher price El Paso might decide to give another seller in the same areas.

The FPC agreed with its examiner that increases for Pure were not "triggered" by El Paso's purchase of gas from another pipeline company at a higher price. Pure was ordered to refund excess amounts it had been collecting since August 2, 1959.

The commission went a step further and concluded that the indefinite escalation provisions in Pure's contracts are contrary to the public interest. But it also found that it did not have the power under existing rules to declare them void. This prompted the commission to amend its rules in a concurrent order to halt similar practices in the future.

Definite escalations are unaffected, however. The commission defines this type of escalation as one setting forth any increases by specific amounts at definite future dates. Also included in this type are clauses which provide for specific price changes to reimburse the seller for production or gathering-tax increases.

PROCESSING BRIEFS . . .

A Polybutadiene - plant will be started this summer by Polymer Corp. Ltd., Sarnia, Ont. The 20,000 ton per year unit is part of an expansion program announced last fall for the Sarnia plant. The unit is expected to go on stream by the end of 1962.

Anhydrous ammonia facilities, increasing producing capacity from 180 tons to 220 tons per operating day, have been completed at the Lockport, Ill., plant of Texaco Inc.

Nine gas dehydration plants will be built by Lone Star Gas Co. along its system in Texas and Oklahoma. Construction will be completed by November at a cost of about $750,000. Two large plants of 100,000 M.c.f.d. capacity will be built in Palo Pinto County and Parker County, Texas. Smaller units will be installed in Smith, Grayson, King, and Brazos County, Texas; and in Jefferson and Cotton County, Oklahoma. A 27,000 M.c.f.d. unit has been completed in Hamilton County, Texas.

Maleic anhydride plant of Pittsburgh Chemical's industrial chemical division is now on stream. The Neville Island, Pa., unit has a capacity of 20 million pounds per year. The firm has, for some time, produced phthalic anhydride and fumaric acid.

An alkylation unit has been brought on stream at United Refining's Warren, Pa., refinery. The 1,100-bbl. sulfuric-acid unit was designed and built by M. W. Kellogg Co.

Also for Refiners . . .

IN THE NEWS: Record surplus of gasoline is shaping up for March unless drastic steps are taken to slow down refinery runs (p. 87) . . . New control plan coordinates residual imports with supply-demand estimates (p. 88) . . . Northern Natural and Great Lakes Pipe Line team up in a new LPG pipeline closely paralleling the Mid-America system (p. 90) . . .

PLUS THESE TECHNICAL REPORTS: Plastic-coated valves stand the gaff (p. 181) . . . High efficiency marks new benzene unit (p. 182).

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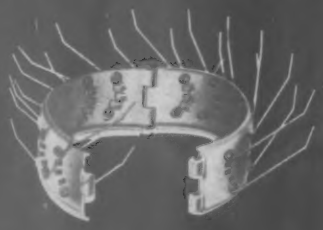

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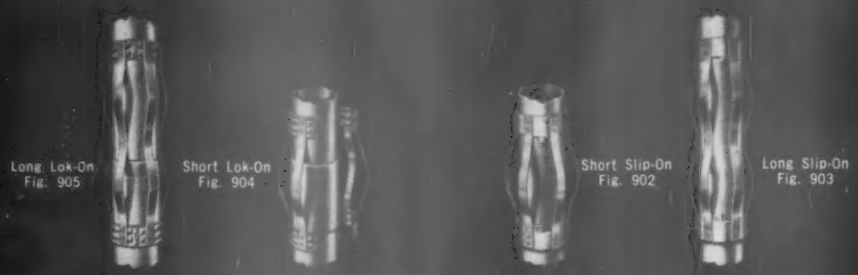

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LA Refiners Fight to Regain Fuel-Oil Market

• Studies show fuel-oil burning does not contribute to smog, nor does it harm plant life or pose a health problem. Industry hopes to kill 6-month fuel ban and substitute rule calling for switch to gas on smoggy days.

THE WEST COAST oil industry goes before Los Angeles officials this week in an effort to recapture a 7-million-barrel fuel-oil market lost as a result of a smog law passed in 1958.

Testimony to be presented before the Los Angeles County Board of Supervisors will show fuel-oil burning:

. . . **Has no connection** with eye-irritating smog.

. . . **Does not harm** humans or plant life due to the sulfur dioxide emitted into the atmosphere.

. . . **Has only a slight** effect on visibility.

Howard Vesper, president of Western Oil and Gas Association and Standard Oil Co. of California, Western Operations, Inc., will point out the fuel-oil ban passed by the county went into effect before the state set ambient air quality standards. The ban prohibits fuel-oil burning from May through October. Now that standards have been adopted, studies show fuel-oil burning and the pollutants emitted into the air fall well under the state's air standards.

Unless the ban is rescinded, Vesper's proposed testimony says, the industry will be forced either to find a new market for the fuel oil or add processing facilities to upgrade it into other products.

As a substitute for the fuel-oil ban, the association proposes what it calls "Operations Fuel Switch." This would outlaw fuel-oil burning:

. . . **If moderate to heavy eye** irritation is forecast. During the last 2 years, there were 76 days when such forecasts were issued.

. . . **If the sulfur dioxide content** of the atmosphere reaches 0.3 ppm for 1 hour. This requirement would be eight times more severe than the state's fresh-air standards, which put the sulfur dioxide content at 0.3 ppm for 8 hours.

In effect, the association's proposal calls for voluntary fuel-oil ban when smoggy weather is forecast and would put fuel-oil burning to a critical test on the remainder of the days.

The size of the resid market lost as result of the fuel-oil ban, known as Rule 62, is based on the 7,336,-381 bbl. of fuel oil sold in 1958 during the 6 months now covered by the ban. On a B.t.u. basis, this means the gas industry is getting a market of 233,000 M.c.f. daily during the days fuel-oil burning is outlawed.

No dangers . . . Part of the testimony to be presented at the hearing is based on a 2-year study made by Dr. Moyer D. Thomas, research chemist working at the University of California at Riverside, Calif.

Dr. Thomas' work shows no pattern develops when you compare the days fuel oil was burned to the days of eye irritation in Los Angeles. Some days when fuel-oil use ran high, eye irritation was low. And other days, eye irritation was high, but fuel-oil burning low (see chart).

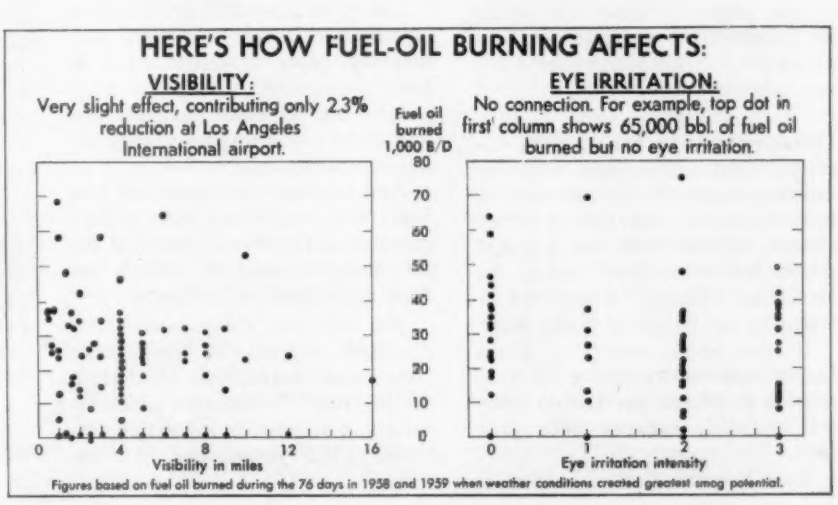
His work also has shown there is no clear cut plant damage traced to fuel-oil burning.

Dr. Thomas also checked the relationship between fuel-oil burning and visibility. Visibility is reduced only 2.3% at Los Angeles' International Airport (see chart) as a result of fuel-oil burning.

Any claims of a health hazard from fuel-oil burning have been shot full of holes by Dr. Charles H. Hine, an associate clinical professor at the University of California's school of medicine and a consultant to the California department of health.

Dr. Hine says the sulfur dioxide content in Los Angeles' atmosphere is not even harmful to unhealthy people. He also says none of the members of the Los Angeles County Medical Association's air-pollution subcommittee has been able to point to a single case of injury or aggravation due to sulfur dioxide levels in the general atmosphere.

CHART DOTS in some cases represent more than 1 day. This means that the dot on the extreme right in the visibility chart represents one or more days when almost 20,000 bbl. of fuel were burned and visibility was 16 miles.



Ruling May Doom Small-Tract Drilling

• State Supreme Court's invalidation of a Railroad Commission proration formula may be a death blow to this kind of drilling. In the wake of the decision: A move to organize small producers in a "fight for rights."

THE Texas Supreme Court issued a far-reaching decision last week which appears to sound the death knell for small-tract drilling in the state.

It threw out as invalid the Texas Railroad Commission's standard formula prorating gas fields containing wells on tiny tracts on the basis of two-thirds on acreage and one-third on the well.

The court appeared to say that the commission can no longer use this formula when its application will result in large-scale drainage of gas to a small-tract well from other leases in the field.

The landmark decision overruled a district-court ruling which upheld the standard formula for prorating gas wells in Normanna gas field of Bee County on the lower Texas Gulf Coast.

The Railroad Commission order was contested by Atlantic Refining Co. and others in district court and the latter's ruling was appealed to the Supreme Court.

The case involves a well drilled by Bright & Schiff, Dallas independent, on a 0.3-acre town-lot tract in the field.

Atlantic attacked the commission proration order as discriminatory, charging that the Bright & Schiff well had only about $7,000 worth of gas under its lease but would be permitted to produce an estimated $2,500,000 worth over a 20-year period.

Proration must be fair . . . The Supreme Court decision said Atlantic's estimates might be overestimated or underestimated, but that evidence clearly showed "not the slightest doubt but what there would be enormous drainage" from other leases to the Bright & Schiff lease.

It cited seven sections of Texas conservation law requiring the commission to prorate production fairly and equitably between wells in a field.

The Normanna field order, it said, "allows a well on a 0.3-acre tract to produce gas at a rate many times greater per acre than a well on a 320-acre tract . . . and we find no substantial evidence in the record justifying such a wide discrepancy in the rate of production.

"Viewing all the facts in the light of the substantial-evidence rule, we think the ⅓-⅔ proration formula is an unreasonable basis upon which to prorate the gas production from this reservoir.

"It does not come close to compelling ratable production. Neither does it afford each producer in the field an opportunity to produce his fair share of the gas from the reservoir."

Attorneys for Bright & Schiff cited past cases affirming the law of capture in their defense of the order. Dealing with these, the court said it does not believe that advantages which a small tract might have had under laws existing prior to proration automatically follow for prorated production.

Oil covered, too? . . . Attorneys acquainted with the many-sided legal battle in Texas over small-tract operations told the Journal last week that the court's decision appears to spell finis to small-tract drilling.

The principles of law laid down by the court in the Normanna case, they say, apply as well to oil as to gas.

It is not yet clear just how this will affect other tiny-tract wells already drilled.

And just how Normanna and new fields with small-tract wells will be prorated in the future, now that the commission's standard formula has been invalidated, is in doubt.

The Supreme Court specifically remanded the case to the District Court with instructions to declare the Railroad Commission order invalid and to grant an injunction forbidding the commission to enforce it.

At the same time, the Supreme Court refused to lay down any rule or standard which the commission could use a guide.

It recalled that it had been urged to do this in some of the briefs filed and declared: "This the court will not undertake to do. We recognize that the Railroad Commission alone is authorized to make the rules regulating the production of oil and gas. While such rules are subject to review by the courts, a court cannot substitute its judgment for that of the commission.

"A court can only pass on the validity of a rule or order properly presented to it for review."

It added significantly, however, that "the responsibility rests with the commission to devise some rule of proration which will conserve the gas in the field in question and at the same time be fair and just to all parties without depriving any of them of his property."

The majority opinion was written by Robert W. Hamilton, associate justice. One justice dissented.

PIPELINE

Budget-type construction programs have been approved by the FPC for three companies. Natural Gas Pipeline Co. of America has earmarked $3,500,000; American Louisiana Pipe Line Co., $3,000,000; and Transwestern Pipeline Co., $3,000,000. No single project can exceed $500,000.

Three Arkansas River crossings of Service Pipe Line Co. will have to be replaced because of the building of Keystone Dam west of Tulsa. One 16-in. crossing and two 12-in. crossings will take the place of 8-in., 10-in., and 12-in. crossings.

A 16-mile, 6-in. distillate line from Knox plant to Velma station in Oklahoma has been completed by

in Texas

And two others did not participate.

Some interpretations . . . Michel T. Halbouty—the man who has conducted a "crusade" against small-tract drilling—called the court decision "one of the most far-reaching ever made—not only for Texas but for the national oil industry."

"This will bring about a new era of thinking," Halbouty said. "This will tend to eliminate a great many unnecessary wells and a lot of inequities. My fight of the past 2 years has been justified by this decision. I think my efforts have created a lot of new thinking."

Halbouty's loudest critic in Texas, Stanley B. Woods, said the decision will lead to the formation of a new organization of smaller independent producers and landowners and that Halbouty won't be allowed to join.

Woods said quarter-page advertisements were being taken in Texas newspapers announcing that the new organization will be formed March 15 in Austin "to fight for our rights."

It will be a permanent organization, he said, and "there won't be any side-bellying with the majors."

Woods was critical of the TIPRO and IPAA organizations for not taking firm stands on the issues of small-tract drilling and forced pooling and unitization. He said legal and legislative committees would be established to carry their views to the state legislature now in session.

Among the organizers, he said, will be Roy Walker, Austin royalty owner; C. L. Wright, Corpus Christi royalty owner; Joe Blalock, Longview operator; and Bright & Schiff, the Dallas firm which lost the supreme court decision.

The organization will be known as the Texas Landowners and Independent Oil & Gas Producers Association.

It won't be tied to any other. "We will have a state-wide campaign with speakers, billboards, and radio time to educate the little folks," Woods said.

Tidewater Oil Co. withheld immediate comment on the case pending a study of the court's decision.

E. B. Miller, Jr., Tidewater vice president and division general manager at Houston, has been active on behalf of wider spacing in Texas. He was named chairman of the Oil Industry Conservation Forum, organized in 1958.

Wider well spacing is one of the Forum's principal aims.

Maher Back as Reed President

• New board of directors will be selected at annual meeting in April. Mecom is now largest stockholder.

JOHN MAHER has returned as president of Reed Roller Bit Co., Houston, and John W. Mecom, Houston independent, has become the company's largest stockholder.

Maher resigned as Reed president last November, and subsequently negotiations were made to merge the company into Dresser Industries, Inc., Dallas. Merger plans fell through when Mecom and Maher joined forces to acquire control of more than 200,000 of Reed's 681,500 shares outstanding.

Among the large blocks which went to Mecom and Maher interests were those held by John H. Blaffer, Ray O. Shaffer, A. H. Rowan, and the Farish interests. Shaffer had been acting as Reed president since Maher's resignation.

Maher announced that a new board of directors will be submitted to the annual meeting April 12 in Houston. The new nine-member board would be composed of three holdover members and six new members, all of Houston.

BRIEFS . . .

Mid-Continent Pipe Line Co. The company also plans to lay a 9-mile 6-in. crude line from Crider field to Maysville station.

A new crude-oil line will be built between Hewitt and Ardmore, Okla., by Bell Oil & Gas Corp. The 12-mile 8-in. line is to be finished by July 1.

Three pipeline projects are planned by Oklahoma Natural Gas Co. They are a 5-mile 12-in. line near Oklahoma City, a 15-mile 8-in. line in the vicinity of Eufala, and a 5-mile 12-in. line near Ponca City.

Permission to move Colorado gas from the Ignacio-Blanco fields to Walsenburg, Pueblo, and Colorado Springs is being sought by the newly incorporated Colorado Gas Transmission Co. The company is asking the Colorado Public Utilities Commission to okay construction of a 20-in. line, more than 250 miles long, from near Durango to Colorado Springs via Wolf Creek pass.

Eventual remote-automatic control of the entire transmission system of Saskatchewan Power Corp. is in the works. Facilities installed so far include telemetering and other remote-control equipment.

More oil was handled by U. S. crude and products lines last year than in 1959, but 72 interstate pipeline companies reporting to the ICC also said revenue was down slightly. The companies handled 1,202,667,250 bbl. in 1960 compared with 1,179,639,053 bbl. the year before. Revenue dipped to $179,935,526 in 1960 from $180,160,895 in 1959.

More Texas gas for Florida is envisioned in expansion plans of Houston, Texas Gas and Oil Corp. and Coastal Transmission Corp. The program, approved by an FPC examiner, calls for 235 miles of laterals and 30,000 hp. in compressor capacity at a cost of $16,126,000 for the former company, and 71 miles of laterals and 12,500 hp. at a cost of $7,275,000 for Coastal Transmission.

Field-welding practices for oil and gas pipelines are brought up to date in the seventh edition of API Standard 1104, prepared by a joint API-AGA committee.

Real Canadian Gas Boom Lies Ahead

• Predicted sales for 1970 call for daily output of 4.7 billion cubic feet. That's equal to 750,000 bbl. daily of crude, and half of the tremendous flow will move into U. S. markets by then.

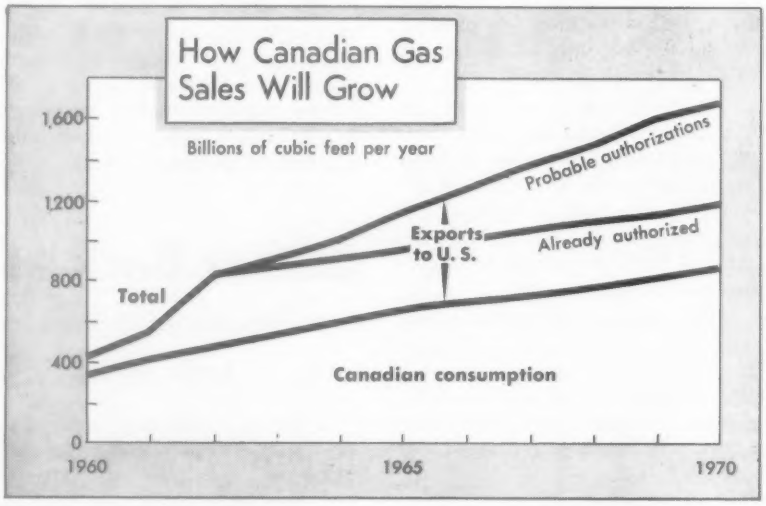
A FOURFOLD increase in sales of Canadian natural gas is expected during the next decade.

This would boost sales from the 1960 level of 420 billion cubic feet to 1.7 trillion cubic feet in 1970. On a daily basis, this would be an increase from 1.2 billion to 4.7 billion cubic feet during the period, the crude-oil equivalent of almost 750,000 bbl. daily.

Exports are due to increase from one-sixth of the total last year to half of all sales in 1970. And, of great importance to crude-oil producers, up to half of the gas export sales will be made in areas of the West Coast, East, and Midwest with little or no competition from crude exports.

This outlook is based on estimates of Canada's National Energy Board for Canadian consumption and presently authorized exports, plus projections of the exporting pipelines.

Investment in the Canadian gas industry has reached $1.4 billion. In the next 5 years another $1 billion in investment is forecast, including $500 million for transmission and gathering, $250 million for processing, $150 million for developing new reserves, and $100 million for distribution.



Growth in Canadian demand . . . Canadian natural-gas sales last year were 2½ times the level of 1956.

That was the year before Westcoast Transmission Co., Ltd., linked northeastern British Columbia reserves to Vancouver and the U. S. Pacific Northwest. It was 2 years before Trans-Canada Pipe Lines, Ltd., opened western Canada reserves to the population centers in the east.

And sales within Canada during the next decade are expected to increase another 2½ times—from a billion cubic feet to almost 2½ billion cubic feet daily, according to the National Energy Board.

A measure of the growth climate is indicated by the Canadian Gas Association's description of 1960 as a "breathing spell" during which sales increased "only" 21%. The industry added 85,000 new customers, boosting the total to 1,150,000. Revenues of $220 million last year are expected to more than double by 1965, excluding the value of exports.

Gas now supplies about 12% of Canada's total energy requirements. With large supplies now available to the entire country, natural gas is being counted upon to grab a much bigger share of the energy market than it now holds.

Gas is not only fueling western industrialization and grabbing an increasing share of its natural space-heating market. It is also dislodging coal and oil from some other markets which have flexibility of fuel choice.

Growth in export demand . . . Probable annual exports by 1970 will more than double the presently authorized level of 328 billion cubic feet, rising to about 840 billion.

Anticipated growth hinges of course on approval by the energy board. Actual export sales are due to reach the authorized level next year. If the board is willing to release all the gas that the pipelines say they can market, then exports could exceed the projected 1970 figure.

The presently authorized 650 million cubic feet daily to be delivered to the U. S. West Coast through the Alberta & Southern system is expected at least to double during the decade. Pacific Gas & Electric Co., the principal backer, estimates its portion destined for California will be inadequate by 1964. PG&E reports a firm market for 900 million cubic feet daily—the equivalent of all presently authorized exports—within 5 years.

Trans-Canada is expected at least to double its 200 million cubic feet daily of exports to the U. S. Midwest by 1965, and has a good prospect to increase sales beyond this volume. Interruptible sales to Tennessee Gas Transmission Co. in New York, already approved by the NEB, also are likely.

Westcoast Transmission is expected to step up its 200 million cubic feet daily of exports to the Pacific Northwest by about 2½ times in the next 10 years.

Revenues from exports will increase from $17 million in 1959 to $100 million next year and an estimated $300 million in 1970.

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This new, advanced version of the field-proven Halliburton Casing Patch Applicator now enables you to obtain an actual, accurate impression of the casing I.D. where a break is suspected *before* applying the Casing Patch.

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With the knowledge provided by the impression, the tool may be re-run with the regular casing patch material on the mandrel. When the mandrel is inflated again, the specially compounded glass fabric and plastic laminate patch is applied to the leak. Excess plastic is forced out at the leak, forming a seal both inside and outside the casing.

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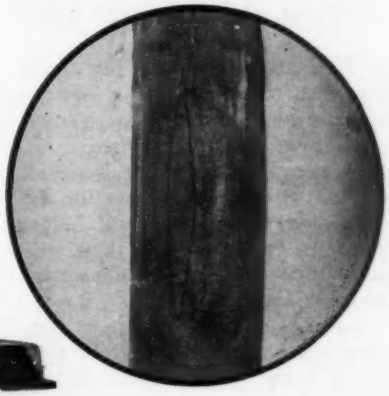
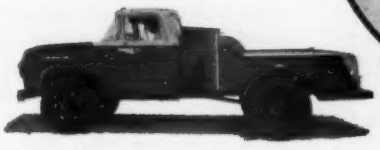


Impression of casing leak



SPECIAL TOOLS FOR SPECIAL PROBLEMS

New Spacing Law Unlikely

. . . in Texas this year. Oil men have so many fights over proposed taxes they hesitate to start another battle.

HOPES are fading fast for legislation this year to modernize well-spacing laws in Texas.

Producers were optimistic earlier this year that bills to reward wider spacing and discourage small-tract drilling would be enacted by the legislature.

Several Texas lawmakers early in January sketched plans for submitting the bills; but now mid-March has passed and the bills still haven't seen the light. This is despite heavy support for action by nearly all the majors and a large and growing group of independent oil operators.

The stumbling block is the threat of heavy increases in oil and gas taxes.

Operators and producer associations now are up to their ears in Austin fighting off proposed hikes in gas and crude production taxes. They feel they cannot afford to alienate any supporters in the legislature by precipitating another fight over spacing.

Early tax victory . . . So far, in the preliminary rounds, the industry is faring quite well in its battle to head off more taxes.

Turning out in force for tax hearings in Austin, operators and producer associations have beaten back for the present Gov. Price Daniel's bill to boost the natural-gas production tax to 10% of value from the present 7%. This would have cost producers another $22,500,000 for the 1-year period proposed.

The gas-tax bill has been detoured to a subcommittee of the house revenue and taxation committee, but it is not yet dead. Other tax measures sponsored by Daniel and affecting other revenue sources have been defeated in the house. This may increase the chance that the gas bill will yet reach the house floor due to lack of any other revenue-raising measure acceptable to the legislators.

Other gas bills . . . Another gas-tax measure introduced by Rep. Robert Eckhardt, Houston, also has not yet cleared the committee.

This one would set up a constant tax rate of 1.505 cents an M.c.f. and split the responsibility for paying it between the producer and purchaser based on sales price for the gas. It would raise an added $40,000,000 a year.

A third bill would require gas producers to sell gas "on premise" to landowners for use in fueling their irrigation pumps. This one is being brought up again after failing to pass the last session.

In the senate, a bill has been introduced which would give natural-gas companies the right of eminent domain to acquire sites for underground gas storage. Texas has no laws except those permitting unitization (and this is not compulsory) which gas companies might apply in attempting to create and operate storage projects.

As a result at least one company, Lone Star Gas Co., Dallas, has had to stand by helplessly while gas it had stored in one of its storage reservoirs was drained out by wells completed by another operator.

Pollution gets attention . . . Several pollution bills have been introduced in the house and senate and others apparently are on the way.

One of the house bills would create a new state agency to handle water-pollution matters. Another would make it illegal for an operator to drill a water well without first obtaining a $25 annual certificate of registration with the state board of water engineers. It also would require filing of well logs with the board.

Senate Grabs Fuel Study Edge

• Approval of resolution calling for study may mean the upper chamber will carry the ball. House marks time.

THE SENATE is moving ahead toward a fuels study of its own in spite of the prospects for a rival study by a House committee.

A record total of 61 senators backed a resolution calling for the study long desired by coal industries. In the next few days, the resolution will go to the Senate interior committee.

Chief sponsors of the study, Sen. Jennings Randolph and Robert C. Byrd, both West Virginia Democrats, plan to ask for public hearings in the near future.

The current resolution was substituted for an earlier measure calling for a joint Senate-House committee to make the study. Randolph said this action was taken after House leaders killed off the idea of a joint committee.

He said the new version appeases New England consumers by promising to consider their interests and eases fears of oil and gas by recognizing that a body of law and policy already exists that is a starting point at least for a fuels policy.

Aim of the study is to look at present laws, policies, and statistics on fuels to see what changes are needed to provide an effective national fuels policy.

The committee can only make recommendations. It would have no power to act on its own.

Membership of the committee would be six Democrats and three Republicans. Vice President Lyndon B. Johnson as president of the Senate would name the committee and its chairman.

A budget of $200,000 is provided for the work, and a deadline of Jan. 2, 1963 is set to report.

A similar measure calling for a House committee cleared the House rules committee and is awaiting action by the full House. This one came after the rules unit turned down the joint committee.

House leaders actually are marking time in hopes the Senate will go ahead first. If so, the House measure would be dropped.

Jungle Rig Drilling in Peru After Long Haul

IT TAKES a lot of sweat and planning to move a complete drilling rig across the wild heartland of South America from Venezuela to Peru.

That job was one of the toughest ever tackled by Loffland Brothers Co., Tulsa-based drilling contractors. It meant shipping drawworks, drilling engines, and all other rig components over 2,700 miles of jungle rivers.

Wildcat locations had to be hacked out of a remote, primeval area of eastern Peru. The job took months.

Now the well, Zorillos 1, is drilling ahead at more than 8,400 ft. on a concession held jointly by Mobil Oil Co. del Peru and Cia. Petroles el Oriente.

Mobil has already invested $3 million in "risk" capital in predrilling exploration in this area of Peru. The company, an affiliate of Mobil International, estimates it will spend $1 million per well on the two-well program.

Zorillos 1, spudded in January, is the first well in eastern Peru's Amazon basin to be drilled by Mobil. The wildcat is almost midway between eastern Peru's only producing oil fields. It is about 40 miles northwest of Agua Caliente, discovered in 1937, and roughly 60 miles southwest of the Macquia discovery of 1957.

Current play . . . Agua Caliente, owned by Ganzo Azul - Cia. de Petroleo (Texas Gulf Producing), has a daily production of about 2,400 bbl. from 14 shallow wells. The Macquia find produces about 750 bbl. daily from 10 wells.

Crude from both fields is barged down the Ucayali River to the government - owned topping plant at Iquitos, 600 miles away, or is hauled 1,800 miles down the Amazon River to the 5,000-bbl. refinery at Manaus in Brazil's interior.

The Macquia discovery excited the oil world because it was the first Peruvian find east of the Andes in 20 years. Macquia was found by Cia. Peruana de Petroleo "El Oriente," a Peruvian company with three German firms as partners.

MORE EQUIPMENT arrives at Mobil's jungle "port" at Zorillos in a remote section of eastern Peru, where a wildcat operation is under way.

Peru's eastern area was opened up under favorable terms for concessions after a big play in the Sechura Desert on the country's Pacific Coast died from an overdose of dry holes several years ago.

Big drawbacks to operations in eastern Peru are its remoteness and the barrier formed by the Andes. It would take major production to finance a pipeline over the Andes, so the two companies which have found oil in the area have moved it in the other direction.

Transportation saga . . . Loffland's Rig V-7 was assembled in Maracaibo for the long journey to Zorillos after the decision was made to drill a deep wildcat on the Aguaytia River in eastern Peru.

The rig was tested at Loffland's big Kilometer 9 yard and shop installation near Maracaibo. It has a Mid - Continent U - 15 drawworks powered by three LRI 600 Cummins diesel engines. There are two 600-hp. pumps, one being tail-driven off the compound and the other an independent skid-mounted unit powered by two Cummins engines. The rig has a 138-ft. portable mast.

Other heavy equipment includes three oil field trucks, two pickups, a welding truck, tractors with dozer blades and booms, light plants, air compressors, and a sand reel.

Movement of the rig and accessories, camp equipment, drilling mud and materials and cement, drill pipe, and other equipment was handled by two ships. One, a 327-ft. converted LST, carried most of the heavy equipment and the pipe and sack material. The other, a 157-ft. ship also equipped with a front-loading ramp, hauled trucks, tractors, the drawworks, and other gear.

The 4,500-mile saga of Rig V-7 took the ships about 1,800 miles through the waters of the Caribbean and the Atlantic and then up the Amazon and Ucayali rivers to the Aguaytia.

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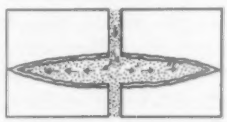


"30,000 frac jobs can't be wrong!"

Two 900,000-Bbl. Tankers Ordered

TWO 130,000-deadweight-ton supertankers which will be the world's biggest by a considerable margin have been ordered by Idemitsu Kosan Kaisha Co., the Japanese refining firm.

The giant tankers are expected to be used on the Persian Gulf-to-Japan run, moving Middle East crude to Idemitsu's 80,000-bbl. Tokuyama refinery.

The ships are big by any standard. On a tonnage basis, they will be 7½ times the size of a T-2 tanker and considerably larger than anything afloat or building.

The biggest tanker now under construction is a 106,500-ton vessel being built in Japan for the Niarchos fleet.

Each of the Idemitsu ships will be able to haul 900,000 bbl. of crude in one load.

Some other dimensions: Over-all length 955 ft., beam 141 ft., and draft, 54 ft. The supertankers will have a top speed of 16 knots.

In comparison to a 45,000-ton tanker, some authorities estimate a 130,000-ton tanker will reduce transportation costs by 30%.

One vessel has been contracted to the Sasebo Ship Industry and the other to Ishikawajim-Harima Heavy Industries, both Japanese shipbuilders. Each is scheduled to cost $14 million, which figures out to approximately $109 a ton.

But just how long the ships will keep the "world's biggest" title is questionable. There are reports some 160,000-ton tankers are being considered.

Oil Hunt in Lebanon Dropped

. . . by West German firm after it chalks up a second dry hole. This marks third exploration fizzle in 15 years.

A WEST GERMAN oil company has given up the third attempt in the last 15 years to find oil in Lebanon.

Gewerkschaft Elwerath disclosed last week that it is throwing in the towel after drilling its second dry hole in the country.

Elwerath bought a half interest in Cit. Libanaise des Petroles for $900,000 in 1959 and agreed to drill at least 13,000 ft. of hole to protect an interest in the 5,500-sq. km. concession (OGJ, Sept. 7, 1959, p. 115).

The announcement by the West German firm drew almost immediate criticism in Beirut and made CLP shares drop sharply on the country's stock exchange. The Lebanese public holds more than 36% of the company and the government owns almost 14%.

Elwerath abandoned the latest wildcat at Adlun in southern Lebanon as a dry hole below 7,000 ft. The company's previous test at al-Qa, in northern Lebanon, was abandoned dry at 8,385 ft.

Two previous efforts were made to find commercial oil in Lebanon. An Iraq Petroleum Co. subsidiary drilled a 10,000-ft. dry hole at Djebel in 1946 and Pacific Western Oil Corp. and C. B. Wrightman, Houston independent, drilled an 8,867-ft. dry hole at South Bekaa in 1953.

India stamps okay on plan to build fertilizer complex

CALIFORNIA Chemical Co. and two partners, one American and the other Indian, will build a $55-million chemical-fertilizer complex on India's eastern coast that will turn out 350,000 tons of fertilizer a year.

The Indian Government last week gave the nod to the Standard of California subsidiary and its two partners, International Minerals and Chemical Corp., Skokie, Ill., and EID Parry, Madras. Parry is the largest producer of fertilizer in India.

The new plant will be built at the port city of Visagapatnam where Caltex operates a 15,000-bbl.-daily refinery.

Naphtha from the refinery will be the basic feedstock for the production of 80,000 tons a year of nitrogen for fertilizer production.

Fred Powell, president of Chemical, said last week that the project has been in the planning stage for months, but until the government granted the group a license it could not be started.

The American companies will be minority stockholders in an Indian company formed to build the plant.

Belgium grants first full-scale exploration rights

BELGIUM has issued two prospecting licenses that pave the way for full-scale exploration in the country for the first time.

One of the tracts, covering 3,756 sq. km., or about 1,450 sq. miles, was awarded to Ste. Champenoise de Recherches et d'Exploitations Minerales (SCREM), formed by seven local coal mining companies.

The acreage is bounded by the Netherlands border on the north and the Meuse River on the east. It includes areas of Antwerp, Limburg, and Brabant provinces. Petrofina will explore the acreage under contract.

SCREM must spend at least $800,000 in the first 5 years, and at least $100,000 per year thereafter. Work will start within 3 months.

The second concession was granted to a Royal Dutch - Shell company, Bataafse Petroleum Mij. The rights cover 2,630 sq. km., or about 1,015 sq. miles in Namur, Hainaut, Liege, and Luxembourg provinces in southern Belgium.

Shell will also spend at least $800,000 in the first 5 years. At least $480,000 of this must be spent in the first three.

Both concessions have a life of 50 years.

Pipelaying Starts for New Indian Crude Line

- **Three spreads working on first part of 720-mile project in the northeast.**

THREE SPREADS are now laying pipe on a 720-mile 14 and 16-in. crude pipeline in northeastern India.

The spreads are working on the first stage of 270 miles of 16-in. line from the Nahorkatiya producing area in the state of Assam to a refinery being built at Nunmati. This section will be completed in November.

The second section, 450 miles of 14-in. pipe from Nunmati to another new refinery at Barauni, in Bihar, will be completed in the second half of 1962. The line will be buried at 4 ft. over its entire length, except at bridge crossings.

Capacity of the system will be 4 million tons per year or about 80,000 bbl. daily. This revises original plans to move 2.75-million tons or 55,000 bbl. daily.

Eight pumping stations, an average of 90 miles apart, will be needed to move the highly viscous crude. Construction has started on stations in the first section. There also will be a station at Moran field, where some of the crude will originate.

The pipeline, along with the producing fields, will be operated by Oil India Private, Ltd., owned two-thirds by Burmah Oil Co., parent company of Assam Oil, and one-third by the government.

Burmah Oil Co. (Pipe Lines) Ltd. has been named as construction authority for the project. It is supervising the pipeline laying by Mannesmann - Saipem Pipe Line Contractors, a joint company formed by Mannesmann AG, Dusseldorf, and SAIPEM, a member of Italy's ENI group.

Stewarts & Lloyds, London, supplied 39,000 tons of 16-in. pipe for the first section. Most of 51,000 tons of 14-in. pipe will be supplied from a new Indian mill at Rourkala owned by Hindustan Steel, Ltd.

Pumping stations will be powered by reciprocating plunger pumps driven by Allen engines. Natural gas will be used as fuel at Nahorkatiya and Moran. Crude will be taken from the line for fuel at other stations.

PRELIMINARY WORK begins in laying of 16-in. pipe at the No. 1 pumping station on a 720-mile 14 and 16-in. pipeline from Nahorkatiya oil field to Nunmati and Barauni, India. A Nahorkatiya well is in the background.

There are about 78 river crossings along the route. The widest, across the Brahmaputra River, will be spanned with a pipeline bridge.

Bids for this bridge are being sought.

The structure, to be built near Gauhati, will have a center span of 2,400 ft. and two symmetrically loaded side spans of 1,200 ft. each. About 230 tons of steelwork will be used in the superstructure, including towers, anchorages, and other equipment. Wire rope and cables will total 200 tons.

Target for moving oil through the bridge's 14-in. line is Aug. 15, 1962.

A 15,000-bbl. refinery is expected to open in December at Nunmati. It is being built with financial and technical help from Romania. The first stage of a 40,000 bbl. refinery at Barauni is scheduled to open in September 1962. The second stage will open by mid-1963. The plant will be built with Russian aid.

Help from Russia also will be given in a project to build a 40,000-bbl. refinery at Gujerat. The plant will process crude from a new field discovered in the Cambay area by the Indian Government's Oil and Natural Gas Commission.

India Getting Soviet Products Again

SHIPMENTS of Russian products to India are resuming after a 3-month suspension.

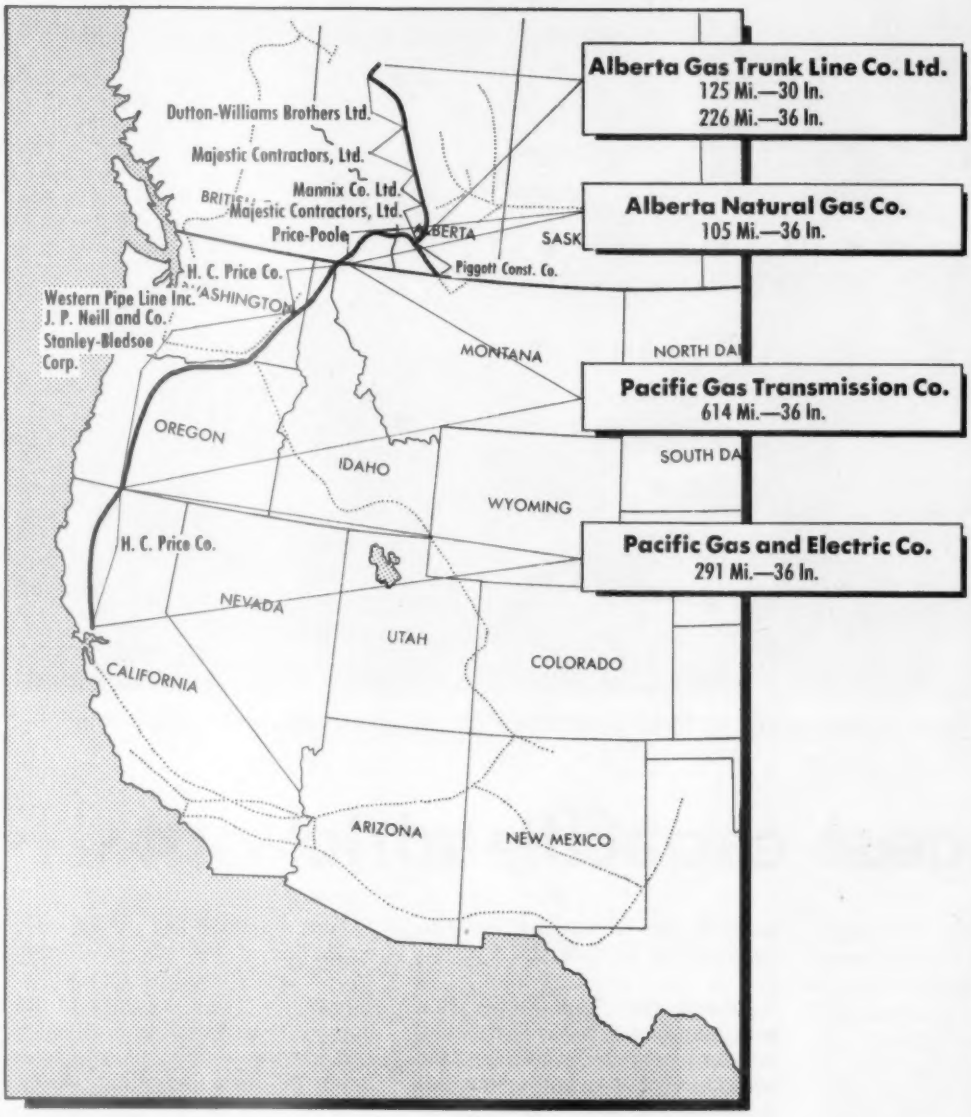
Two tanker deliveries per month will be made to the government-owned Indian Oil Co. The shipments will be part of an agreement under which Indian Oil will take 1.5 million tons of Soviet products over 4 years.

The first two tankers are scheduled to arrive this month with 20,000 tons, or about 280,000 bbl. of products. About half will be kerosine, half high-speed diesel oil.

Imports of Russian products were suspended in November because of a lack of government-owned storage and distribution facilities. Of 11,390 tons (about 80,000 bbl.) of diesel fuel which arrived in August, about 4,000 tons still are unsold.

A shipment of 10,784 tons of kerosine, which arrived in November, has been disposed of.

The government got into the import business last year.



SPECIAL REPORT ON

Alberta-California Gas Pipeline System

The Journal's pipeline editor, Paul Reed, gives you the full story of this significant new development—design of the line and its stations, underground storage, reserves, markets, and costs. Special emphasis is given to an account of how field plants facilitate construction.

The Oil and Gas Journal's Annual
NATURAL-GAS PIPELINE REPORT

Strategic planning, with extensive use of field construction plants, gives Alberta-California line . . .

Biggest capacity at low cost—

DESIGN FEATURES and unique plans for construction are vital parts of the strategy of Pacific Gas & Electric Co.'s current Alberta-California project. So are the types of arrangements for acquiring gas and transmitting it on an unusual cost-of-service basis to San Francisco from Canada—the region of the last undeveloped reserves in North America.

Canadian gas is not cheap. Therefore it has been essential to provide economical transportation utilizing the advantages of the large-diameter 36-in. pipe so that Canadian gas would be competitive from the start with gas from other sources. In 1962, Canadian gas delivered to PG&E at the Oregon-California border will cost about 35 cents per M.c.f. This is slightly above what PG&E would pay for gas from areas outside California in the U. S. As capacity is increased from year to year, incremental cost for additional compressors will be such that the cost per unit of gas transported will diminish. The line has been designed for ultimate delivery to California of 800 M.M.c.f.d.

Record size. This is the first undertaking of a major distributing firm for piping gas from beyond the boundaries of the United States. It is the longest 36-in. pipeline ever laid. All the pipe from the Sacramento Valley in California to the Alberta border will be internally coated—the longest internally coated transmission line.

The system from San Francisco Bay to the Alberta border is the first to be planned in advance so that all the main-line pipe will be double jointed and coated at plants before coming to the right-of-way. This means that almost half the welding and nearly all the external coatings and all the internal coatings are done before pipe laying begins. It is also the first pipeline project to cost as much as $300,000,000 to be built in a single year.

Experience with practices, characterizing the project, promise to have important influence on future pipelining.

Four owners. The 1,400-mile trunk line of the project is engineered and supervised by two organizations. Four segments of the line are owned by four companies, each having a different ownership setup. A brief indication of the division of work and ownership is given here. Details are described in the final section of this article.

The main line starts with 30-in. in the Whitecourt gas fields of Alberta and continues as 36-in. from Rocky Mountain House, Alta., to Antioch, Calif., in the San Francisco area. There it connects with the distribution system of PG&E.

U. S. ownership. California section of 296 miles is owned, engineered, and constructed by PG&E. H. C. Price Co. contracts coating and pipe laying for all except 5 miles of river crossings and for part of the double jointing.

North of California, Bechtel Corp. and Canadian Bechtel, Ltd., are serving as engineers and managers of construction.

Oregon, Washington, and Idaho

HOLDING FAST to prevent slippage, a tractor helps Majestic Contractors, backhoe prepare rough ditch for Alberta Gas Trunk Line Co.'s line. Another backhoe works in middle background. Town of Coleman, Alta., is in valley in background.

it's the longest 36-in. ever laid

614-mile section is to be owned and operated by Pacific Gas Transmission Co. affiliated with PG&E and also partly owned by other interests and the public. Engineering, management, and supervision are handled by Bechtel Corp. Plant operations for double jointing and coating are contracted by Stanley-Bledsoe Corp. Pipe laying is contracted by H. C. Price Co. and by J. P. Neill & Co., Inc., and Western Pipeline, Inc., as a joint venture.

Canadian ownership. British Columbia 107-mile section is to be owned and operated by Alberta Natural Gas Co., which in turn is owned one-third by Pacific Gas Transmission Co., one-third by Westcoast Transmission Co., Ltd., and one-third by the public. Engineering and construction are supervised by Canadian Bechtel, Ltd. Pipe double-jointing and wrapping plant and pipe-laying operations are contracted by Price-Poole of Canada, Ltd., a joint venture of H. C. Price of Canada, Ltd., and Poole Construction Co., Ltd.

Alberta section of the main line consisting of 125 miles of 30-in. from White Court followed by 226 miles of 36-in. from Rocky Mountain House to Crowsnest Pass at the British Columbia border is managed and constructed and is to be operated by Alberta Gas Trunk Line Co., Ltd. Engineering is handled in collaboration with and under the direction of Canadian Bechtel, Ltd.

Pipe laying for Trunk Line has been contracted by Majestic Contractors, Ltd., for 113 miles of 36-in. main line, 63 miles of 30-in. main line, and 38 miles of 22-in. feeder lateral; by Alberta Consolidated Pipe Line Builders (a joint venture of Mannix Co., Ltd., Piggott Construction, Ltd., Banister Construction Co., Ltd., and Marine Pipeline & Dredging, Ltd.) for 113 miles of 36-in. main line and 64 miles of 16-in. delivery lateral to the Montana border; and by Dutton-Williams Brothers, Ltd., for 62 miles of 30-in. main line and 20 miles of 22-in. feeder lateral. Additional laterals totaling approximately 400 miles are planned for construction within a few years.

Gas is bought by Alberta and Southern Gas Co., Ltd. (wholly owned by PG&E), and transported in turn by Alberta Gas Trunk Line Co., Ltd., Alberta Natural Gas Co., and Pacific Gas Transmission Co. to the California border, where PG&E buys it.

Alberta Gas Trunk Line, Alberta Natural Gas, and Pacific Gas Transmission also will carry in the pipeline Alberta gas to be exported from Canada by Westcoast Transmission Co., Ltd., and wholesaled to local utilities in the Pacific Northwest by El Paso Natural Gas Co.

In addition, Canadian-Montana Pipe Line Co. will export to its parent, Montana Power Co., Alberta gas to be carried through a portion of Trunk Line's main line and a lateral to the Montana border.

Information for these articles was obtained from PG&E, PGT, and Bechtel in San Francisco, and during a field trip to plant and construction operations in California and Oregon.

LINING UP at the double-jointing unit at the plant of H. C. Price Co. at Burney, Calif., serving the PG&E section of the project. Two 40-ft. lengths of 36-in. are brought together for automatic submerged-arc welding.

Record use made of field plants

OUTSTANDING feature of the Alberta-California pipeline construction program is the extensive use of field plants. There has never before been a project where field plants have been used on such a large scale.

By double jointing at plants, almost half of the welding and nearly all the coating are done before the pipe reaches the right-of-way. The utilization of field plants in pipelining follows trends in fabrication shops where sub-assemblies are made as far as possible before final assembly. A pipeline spread functions like a traveling assembly line.

Plant advantages. Field plant work reduces pipe-handling operations on the right-of-way. Fewer men are needed in the pipe-laying spread.

Cost of automatic welding for double jointing at field plants is considered at a standoff with that of manual welding on the right-of-way. But more contractors are preferring the double joints. Savings from using the 80-ft. joints produced by double jointing are now regarded as 15 to 20%, when considering all costs including those for double jointing and stringing. Stringing costs are about the same for 80-ft. joints on this project as they would be for 40-ft. joints. The savings come from increased spread production footage.

The large amount of double coating and wrapping with rigid inspection on this project can be done more effectively at field plants than on the right-of-way. Elimination of dope gangs reduces fire hazards which become important in forest areas during dry weather.

Plant operations. Contracts for plant operations were made in different ways for the project.

H. C. Price Co., a contracting firm which has been pioneering field plant operations, is the only pipe-laying contractor on U. S. sections of this project which runs its own plants. These serve the Price operations for laying 435 miles of 36-in. pipe.

- At Burney, Calif., Price double jointed and Somastic coated a portion of 291 miles for the California section of the project in the early months of the job.
- At Napa, Calif., Somastic coating will be applied by Price on pipe double jointed at a plant of Kaiser Steel Corp. near the Kaiser pipe mill, scheduled for March operation.
- From Rosalia, Wash., to the Idaho-British Columbia border, where Price will lay 146 miles, two plants will be set up for double jointing and applying asphalt enamel and wrapping.
- In British Columbia a plant for double jointing and asphalt coating will serve the 107 miles contracted by Price-Poole.

Stanley-Bledsoe Corp. has two plants for double jointing and applying epoxy resin internal and asphalt external coating now operating in Oregon to serve pipe laying of Western Pipeline Co., Inc., and J. P. Neill & Co., Inc. The plants are being moved through Oregon into Washington as the work progresses. Pacific Gas Transmission and Bechtel contracted directly with Stanley-Bledsoe for this double jointing in Oregon and part of Washington.

In Alberta, Dutton-Williams Brothers, Ltd., is double jointing for its own pipe-laying operations and for those of Majestic Contractors, Inc.

Coating will be done on the right-of-way in Alberta.

Joint design. Joint design for double jointing with submerged arc welding for PG&E and PGT was determined on the recommendations of Pacific Construction Co. to Pacific Gas & Electric Co. and Bechtel Corp. This joint design has a ⅜-in. land and a 30° bevel for all wall thicknesses of 36-in. pipe.

Two divergent views are strongly held regarding land thickness. Considerable operating experience has indicated that greater production can be obtained with a thinner land of approximately 3/16 in.—just sufficient to simulate a backup ring. Another view anticipates that the trend will be toward thicker lands requiring more amperage and changes in the control balance.

Types of plants. The four automatic welding units operating during early months of the project—one of H. C. Price Co., one of Kaiser Steel Co., and two Stanley-Bledsoe Corp. are of three kinds representing different forms of the technique introduced by Price in 1957.

For this automatic submerged-arc method, joints are finished with thick lands. They are butted tightly together for welding first by two outside beads followed by an inside bead. (OGJ, Apr. 22, 1957, p. 104,

FACILITIES for applying epoxy resin on the inside of the pipe. Pipe rolls on racks from the double-jointing unit to this internal-coating operation. From there it goes to the external coating and wrapping unit.

PIPE for Pacific Gas Transmission Co. is receiving the conventional asphalt enamel-glass-fiber-asbestos-felt wrapping. Here employes of Stanley-Bledsoe Corp. adjust the pipe wrapping machines in a shed at the big Sprague River, Ore., field plant.

Dec. 16, 1957, p. 82, Mar. 9, 1959, p. 120, Feb. 13, 1961, p. 70).

Sprague River plant. The type of plant operated by Stanley-Bledsoe at Sprague River, Ore., is the largest and most comprehensive in pipeline field operation.

Racks have been planned so that the pipe can be rolled from one operation to another for double jointing, internal coating, and finally external coating. In going the 985-ft. length of the racks the pipe is never lifted till it leaves the cooling racks.

Equipment in each of the two Stanley-Bledsoe yards cost approximately $700,000. Each yard has 85 men. Half of them work at external coating. The others are about equally divided between double jointing and internal coating.

Pipe in 40-ft. joints is brought to the double-jointing racks by fork lift.

The automatic submerged-arc, double-jointing plant is of the type which pioneered preset, locked-in, push-button control and operates with three welding heads—two external and one internal at three stations (three racks).

Early in January when the author visited the plant it was running on 36-in. by 0.438-in.-wall pipe finished with a 30° bevel. One end had a conventional 1/16-in. land. The other end had a 0.375-in. land especially cut for submerged-arc welding. Reverse polarity direct current was used for all beads. Granulated flux was Linde grade 50 48 by 48. The electrode was Linde No. 36 ⅛-in. wire.

The three beads were run by the following procedures.

1. First outside bead.

- Welding at 2¾ in. off center-nozzle tilted 1° backward.
- Welding speed 73 in. per minute.
- 850 amp. d.c.
- 25 volts.
- 1-in. tip to work distance.

2. Second outside bead.

- Welding at 2¾ in. off center-nozzle 5° forward.
- Welding speed 49 in. per minute.
- 750 amp.
- 1-in. tip to work distance.

3. Inside bead.

- Welding at 1 in. off center.
- Welding speed 40-in. per minute.
- 690 amp.
- 34 volts.
- ¾-in. tip to work distance.

Because of the present method of manipulating rollers so as to hold pipe ends in compression during the early part of running the first bead, it has been possible to simplify operations and improve weld quality.

Pipe rolls from the double-jointing plant to the plant where a grit blaster cuts down the inner wall surface to gray metal before it is coated with epoxy. On cold mornings the grit blaster is preceded by a preheater for defrosting.

The last operation is coating with asphalt (3/16-in.) wrapped with glass mat imbedded in it and also wrapped with a 15-lb. asphalt-impregnated outer wrap.

The production schedule calls for 100 joints of 80 ft. per 12-hour day.

In transit from plant to right-of-way pipe is protected by resting on 1-in.-thick rubber pads on stringing truck and trailer. Three 80-ft. joints of 0.438-in.-wall pipe are carried in a load. Two joints of 0.656-in.-wall pipe make a load.

Burney plant. The H. C. Price Co. plant at Burney, Calif., has been double jointing and applying Somastic coating.

Pipe came from the mill to the plant already internally coated with epoxy and finished with a thick ⅜-in. land and only a small 30° bevel on the outside edge of the end of

RUNNING INTERNAL LINEUP CLAMP into pipe at Burney, Calif., plant. At left, rack operator in hut manipulates controls for pipe movement.

the joint to be welded by automatic submerged arc. The other end has the conventional joint design for manual welding.

When the author visited Price's Burney plant recently, pipe was brought to the double-jointing plant by tractor boom with double load line making it possible to carry two joints at once.

Cold Weather Protection

For protection in cold weather, housing was provided for the rack operator and the operator for welding inside the pipe. One welding head runs both external beads; another runs the internal bead. Principal improvements are the lineup stabilizer and the speeding of rack operations by use of two separate pumps for hydraulic power.

Wholly automatic welding without manual tacking reduces porosity resulting from lack of affinity between weld metal of manual and automatic welding.

A special type of pneumatic air clamp is being used.

The plant can operate through snow and rain. Only strong wind or heavy moisture can shut it down.

Reverse polarity direct current, and ⅛-in. wire is used on running all three beads.

Welding procedure was as follows:

1. First outside bead.

- Welding speed 85 in. per minute.
- 775 amp. 32 volts.

2. Second outside bead

- Welding speed 55-in. per minute.
- 700 amp., 35 volts.

3. Inside bead

- Welding speed, 36-in. per minute, according to schedule, but it is practical to run this bead at 54-in. per minute.
- 700 amp., 34 volts.

Plant production has been 87 to 97 welds per 8-hour day.

Double-jointed pipe rolls to the Somastic coating plant operated by Price.

Napa plant. While the Kaiser Steel Corp. double-jointing plant at Napa, Calif., has a certain basic similarity to the Price technique, it diverges with distinct innovations. These have been adapted to girth welding from methods for seam welding at the company's pipe mill.

The Kaiser double-jointing plant, located separately from the company's pipe mill, starts production on approximately 175 miles of 36-in. pipe for the California section of the project.

Fork lifts bring pipe from the mill to the plant. The double-jointed 80-ft. joints go to the nearby coating plants.

Internal application of epoxy coating at Napa has been subcontracted by L. C. Russell Co., Inc., Beaumont, Tex. Somastic external coating is applied by the H. C. Price Co. plant moved from Burney to Napa.

Principal departure from previous practice is running two beads instead of the usual three beads. The first bead is on the inside followed by one outside bead run with a special type of granulated-flux backup device. There are two stations at the welding racks.

Joint design. Joint design is the same as for the pipe furnished to other double jointing plants of the project. But the slight 1/16-in. bevel is on the inside. The first bead is run inside after the pipe has been lined up by a self-propelled clamp on the end of a boom and manually tack welded with tacks 2 to 3 in. long at 10 to 12-in. intervals. Lineup and tack welding are at a station preceding the one where the first bead is run.

An operator goes into the pipe on a boom for running the first bead. The inside edge, beveled as low as possible, facilitates desired penetration and serves as reinforcement for a flat smooth weld without a high crown, for pipeline needs.

In running the outside beads, the weld rolls in granulated flux 1½ in. thick held on the pipe by a rubber belt with a groove in the center. The belt is on rollers in a fixed position on the pipe. From this device the flux flows to an endless belt underneath.

This type of flux handling facilitates maximum penetration without burn through. Flux is handled this way in running longitudinal seams at the Kaiser pipe mill but this is the first time the method is used by Kaiser for double jointing. In making pipe, Kaiser runs the first submerged arc bead on the inside for the longitudinal seam.

In Kaiser's double jointing, straight direct current is used. Operation is fully automatic with push-button preset control. Electrode is 5/32-in. wire. Welding speed is 50 to 60 in. per minute. Production has been scheduled for 90 to 100 joints per 8-hour day—a complete weld every 5 minutes.

From Napa, 80-ft. joints are trucked to the job.

LOWERING IN the crossing of the Bow River west of Calgary. Side-boom tractors manipulate the 36-in. pipe. Doughnut-shaped river weights made in two sections are bolted together. Wooden slats protect pipe surface from rocky river bottom.

Field practices set by engineers

AS PART of the program for getting the most for the construction dollar, Pacific Gas & Electric and Bechtel made an effort not only to plan for adequate facilities with economy but also to furnish advance information to assist contractors in bidding.

A rock survey was made to furnish data to contractors before bidding. The pipeline route was core drilled by PG&E and Bechtel in the United States up to the Canadian border. With a portable drill on the back of a power wagon, diamond - drilled ⅞-in. cores were taken every 1,500 to 2,000 ft. This was the first time PG&E has undertaken such a survey for contractors. There was no rock clause in the contracts. In British Columbia rock can be easily seen at the surface along the pipeline route.

Field practices. Grading of the 100-ft. wide right-of-ways is of good quality.

In the California section it is specified that ditch shall be dug on alignments and to grades established by the company's survey.

In the California section, where the standard PG&E practice is followed, the company engineers set grade stakes for the trench. Alignment is to a string. The grade is checked in the bottom of the ditch.

Minimum ditch width is 1 ft. more than the outside diameter of the pipe. Minimum ground cover over the pipe, with some exceptions, is 42 in. In rock it is 24 in. except at county and private road crossings, where it is 36 in.

In gulches, beds of dry washes, drainage ditches, canals, and tillable lands cover is 60 in.

Trenching needs. North of the California border trenching requirements are similar. There are exceptions to those for grading the ditch and some other cases.

Special attention is given to protecting the coated pipe. Skids are padded. In hauling, pipe is supported on padded cradles shaped to fit the curvature of the pipe. Pipe sections are separated and secured so that they do not bear against each other. No stockpiling is to be done higher than two tiers.

When the temperature of the bare metal is lower than 50° F., the pipe is preheated to at least 100° F. and not more than 400° F.

Stringer bead. At least three welders are required for running the stringer bead. Lineup clamp must be left in place until the stringer bead is completed. For cleaning the beveled ends prior to welding, power-driven grinders with abrasive fiber disks are required. Paint is removed from the beveled end a distance of 2 in.

In lining up for welding, misalignment of the pipe wall (high-low) is not to exceed 15% of the wall thickness or 1/16 in., whichever is the lesser. Only minimum hammering in lineup is permitted. When hammering is permitted by the inspector, a flatter must be used as a buffer between the pipe and the hammer. Or a bronze hammer may be used.

Where pipe of different wall thickness is joined by a weld, two passes must be run on the inside in addition to the regular outside weld.

All valves 16 through 36 in. are furnished with a plastic coating applied by the manufacturer. The contractor is thus relieved of the responsibility of coating such valves except for abraded surfaces.

Piping protection. Aboveground piping is protected by two coats of rust-inhibitor primer followed by a silver-gray finish coat.

Electrical holiday detectors for inspecting protective coatings are set at a minimum of 12,500 volts for enamel coating and 20,000 volts for Somastic coating.

In the final pressure testing of the completed line, hydraulic pressure will be applied to produce a stress not more than 100% of the guaranteed minimum yield of the pipe.

Bending by bending machines is to be limited to 1½° per pipe diameter for the bend section of the pipe

with a deformation for out of roundness not to exceed that allowed by ASA B31.8-1959. When a smaller radius is required, a fabricated fitting with a radius of not less than three pipe diameters shall be used.

No provisions will be made for laying slack in the run of the pipeline.

Inspection. Radiographic inspection of from 10 to 20% will be used on the total amount of main-line welding in Class 1 and Class 2 areas.

For making a complete weld on 36-in.-diameter, 0.438-in.-wall pipe it takes 2 hours for a utility welder. Main-line welding crews for such work have at least three stringer-bead welders and four hot-pass welders, plus six to nine welders in the firing line.

All of the pipe from the mountainous areas of northeastern California to the British Columbia-Alberta border is internally coated with epoxy.

For the lines of the project in Alberta, double jointing and plastic coating are not required.

Emphasis is being given to have good fit of the pipe in the ditch where special attention is given to having it properly supported and protected with padding.

Terrain. The project traverses terrain of great variety and altitudes ranging from 6,600 ft. to sea level. In northern California there is much volcanic rock. Only the British Columbia section is more rugged than the Pit River section in northeastern California. The line crosses much irrigated land in former lake bottoms in northern California and Oregon where the water table is high the year around. There are extensive arid regions in Washington and Oregon. British Columbia and parts of western Alberta are mountainous.

During the late spring, construction is subject to delays in the plains and foothills country of Alberta because of the effect of the thaw on highway beds. Traffic may be stopped by the road bans.

National forests and other forested areas require fire precautions in the dry months. Spark arrestors must be used there on tractor exhausts. The reduction of work on the right-of-way due to the advanced work at double jointing and coating plants reduces fire dangers in areas where hazards are critical.

The line will operate at some locations where temperatures have been recorded as low as −50° F.

Designed for 1,173 M.M.c.f.d.

THE Alberta-California system has been designed for ultimate export of 1,173,000,000 cu. ft. per day. Ultimate deliveries include:

	M.M.c.f.d.
Canadian Montana Pipe Line Co.	36
El Paso Natural Gas Co.	303
Pacific Gas & Electric Co.	800

Compressor-station spacing, diameter and wall thickness of main line, and other factors are incorporated in the economic design developed for this throughput.

Total estimated proved reserves of pipeline gas, as of July 1, 1960, available to Alberta and Southern Gas by contract or option under its export permit are summarized as follows:

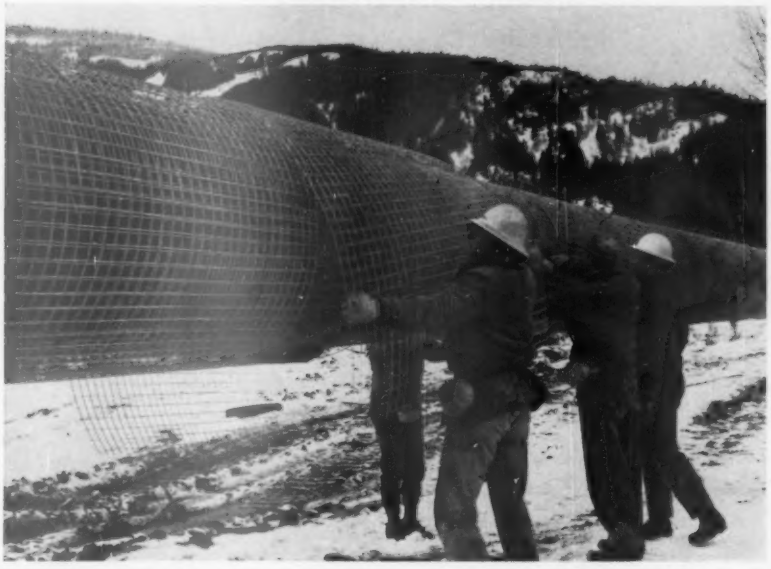
	Billion cubic feet at 14.73 psia.		
	Under contract	Under option*	Total
Berland River	132	132	264
Brazeau River	....	19	19
Burnt Timber	....	37	37
Caroline	29	....	29
Carson Creek	....	73	73
Crossfield	490	....	490
Fox Creek, North and West	3	4	7
Homeglen-Rimbey	156	....	156
Kaybob	201	....	201
Lobstick	78	....	78
Lovett River	....	80	80
Minnehik-Buck Lake	184	....	184
Paddle River	26	....	26
Parkland (Pine Coulee)	14	....	14
Sarcee	99	....	99
Stolberg	....	69	69
Waterton-Castle River	452	....	452
Westerose South (Dick Lake)	653	....	653
Whitecourt area	843	26	869
Wildcat Hills	116	146	262
Totals	3,476	586	4,062

*The option agreements extend for varying periods, terminating between December 31, 1961, and September 8, 1969. In general, they require the producer to sell gas to Alberta & Southern under an already agreed form of contract when and if the reserves discovered are adequate in the producer's opinion to warrant development for commercial purposes.

The average heating value of the gas reserves controlled by Alberta & Southern is estimated at 1,020 B.t.u. per cu. ft.

In addition to the proved reserves available to Alberta & Southern by contract or option in the above fields, there is an estimated 250 billion cubic feet of proved reserves in those fields which are not contracted to any market. These additional reserves are available for purchase, in competition with others,

PLACING SLASH for corduroy road in muskeg country in West Central Alberta for Dutton-Williams Brothers, Ltd., operations. This section of Alberta Gas Trunk Line Co.'s main line is on the edge of Pembina oil field.



PREPARING REINFORCING STEEL for gunite coating of 36-in. pipe for one of the eight crossings in 8 miles on the Moyie River in the Pacific Gas Transmission Co. section contracted by H. C. Price Co. This work is just south of the British Columbia border.

and export by Alberta & Southern under existing export authorizations, and could be handled with pipeline facilities now being constructed.

Following are estimated ultimate volumes available from fields under contract to Westcoast Transmission Co. (billions of cubic feet):

East Calgary	97.8
Savannah Creek	63.5
Future purchases	151.7
Total	313.0

The design for initial operation of the pipeline is based on a maximum day export of 654 M.M.c.f.d. from Alberta for delivery of 36 M.M.c.f.d. to Canadian Montana Pipe Line Co., 152 M.M.c.f.d. to El Paso Natural Gas Co. at Spokane, Wash., and 452 M.M.c.f.d. to Pacific Gas & Electric Co. at Antioch, Calif.

Deliveries from the individual fields to Alberta & Southern are assumed to be made to a central location in each field and to be dry and free from liquid hydrocarbons, sulfur, and other objectionable materials.

The flow formula used for calculating pressure drops in the mainline pipe was the classic gas-flow equation adjusted for elevation differences:

$$KQ^2Lf = Y\,(P_1^2 - P_2^2) + Y^2\,\Delta h\,(P_1 + P_2)^2$$

The flow formula used for calculating pressure drops in laterals was the same formula without the elevation adjustments:

$$KQ^2Lf = Y\,(P_1^2 - P_2^2)$$

The formula used for calculating the horsepower required at each compressor station:

$$BHP = \frac{BHP}{MM} \times \frac{1}{Y}$$

Nomenclature for formulas:

Q = volume, M.M.c.f.d. at 14.73 psia. and 60° F.

P_1 = upstream pressure, psia.

P_2 = downstream pressure, psia.

L = distance between changes in elevation, miles.

Y = deviation from Boyle's law.

d = inside diameter of pipe, in.

f = friction factor.

K = flow constant.

T = flowing temperature, °R.

T_o = temperature base, °R.

P_o = pressure base, psia.

S = specific gravity of gas, no units.

D_a = density of air, lb. per cu. ft.

Δh = elevation factor.

h = change in elevation of pipeline gradient. Downhill flow = positive. Uphill flow = negative.

BHP = brake horsepower.

BHP/MM = brake horsepower required to compress 1 M.M.c.f.d. at 14.73 psia. and 60° F.

Basic Assumptions

1. Pressure base: For flow and horsepower calculations all flow rates shown on the flow diagram are converted to volumes at 14.73 psia. pressure base. Flow constants and flow rates used in the formulas included herein are all based on 14.73 psia. pressure base.
2. Specific gravity = 0.645.
3. Flowing temperature = 60° F.
4. Compressor-station piping pressure losses: Suction side of compressors = 8 psi. Discharge side of compressors = 2 psi.
5. Compressor fuel gas, reciprocating units = 8 cu. ft./b.hp.-hr.
6. Compressor fuel gas, centrifugal units = 7.2 cu. ft./b.hp.-hr.
7. "K" value of gas = 1.27.
8. Pipeline gas loss = 1% of transmitted volume per 1,000 miles of pipeline. (Not part of exported quantity of gas.)
9. Friction factors used were:

O.d. (in.)	f
36	0.0023
34	0.0023
30	0.0023
26	0.0023
24	0.0024
20	0.0025
18	0.0025
16	0.0026
12	0.0027
10	0.0028
8	0.0029

Determining Variables

1. The deviation from Boyle's law (Y) was determined by method of R. V. Dunkle for a natural gas with 2.9% nitrogen. (See PCGA Proceedings, Vol. 35, page 80 for "Deviation of Natural Gas from Boyle's Law" by R. V. Dunkle).
2. The brake horsepower required to compress 1 M.M.c.f.d. (b.hp./M.M.) was determined from the Cooper-Bessemer curve entitled "Brake Horsepower for Reciprocating Gas Compressors," which is based on an assumed value of the ratio of specific heats equal to 1.27.
3. The elevation (Δh) was determined from contour map with contour intervals ranging from 250 to 1,000 ft.
4. The friction factor (f) for 26 in. through 36 in. is based on test data by PG&E: for lines smaller than 26 in. it is based on Bureau of Mines tests conducted by R. V. Smith, J. S. Miller, and J. W. Ferguson.

Evaluation of Constants

1. Elevation factor (Δh):

$$\Delta h = \frac{SD_a T_o h}{P_o T (144) (2)}$$

$$= \frac{(0.645) (0.07656) (520) h}{(14.73) (520) (144) (2)}$$

$$\Delta h = (11.64 \times 10^{-6}) h$$

2. Flow constant (K):

$$K = \frac{ST (10)^{12}}{(6.25) (24)^2 T_o d^5}$$

$$= \frac{(0.645) (520) (10)^{12}}{(6.25) (24)^2 (520) d^5}$$

$$K = 1.792 \times 10^8/d^5$$

Basic design criteria: Maximum pipeline working pressure is pressure required to produce a stress equal to 72% of specified minimum yield strength of the pipe.

Gas Sales

The initial gas sales from the project are as follows:

	Average day gas sales M.M.c.f.d. at 14.73 psia.
Gas purchased by Alberta and Southern Gas Co., Ltd., for resale to:	
Canadian Montana Pipe Line Co. near Cardston, Alta.	30.0
Pacific Gas & Electric Co. at Antioch, Calif.	414.1
Subtotal	444.1
Gas purchased by Westcoast Transmission Co., Ltd., for resale to:	
Coleman, Alta.	1.6
Fernie, B. C.	0.5
Cranbrook, B. C.	5.9
Yahk, B. C.	0.1
Creston, B. C.	0.5
El Paso Natural Gas Co., at Spokane, Wash.	151.7
Subtotal	160.3
Total	604.4

Alberta & Southern has also contracted with Canadian Western Natural Gas Co., Ltd., (Calgary) and Northwestern Utilities, Ltd., (Edmonton) to supply gas to Alberta Utilities if and when required. Alberta Utilities has made similar arrangements with other exporters.

Pipe

All of the 36-in. pipe for the project between San Francisco and Alberta will be API 5LX52 furnished for construction in 80-ft. joints with the exception of pipe for crossings.

The basic wall thickness is 0.438 in. for most overland terrain; for river crossings 0.531 in.; for sections downstream from compressor stations 0.656 in.; for certain populated areas in Washington 0.453 in.

Range of wall thickness is indicated by list of pipe furnished for the California section.

Miles	Wall thickness (in.)	Approximate wt./ft. (bare)
173.25	0.438	166.17
10.9	0.453	171.93
54.0	0.469	177.88
35.0	0.500	189.57
11.9	0.531	201.15
5.0	0.563	212.45
0.7	0.625	236.69
290.7		

Main through-conduit block valves have been located to form approximately 15 to 20-mile sections. Accessibility will determine locations.

In construction of the line, provision has been made at station sites for piping connections for later installation of piping for scraper traps.

Compressor Stations

There will be four initial compressor installations totaling 40,000 hp.

Station No. 1 will be in the Alberta Natural Gas Co. section, just west of Crowsnest Pass, B. C. It will have four 3,500-hp. gas-driven reciprocating compressor units.

In the Pacific Gas Transmission Co. section there will be a station (No. 4) at Samuels, Idaho, near Sandpoint, with one 6,000-hp. gas-turbine-driven unit; a station (No. 8) at Wallula, Wash., near Walla Walla, with two 5,000-hp. gas-engine-driven centrifugal units; and a station (No. 13) near Chemult, Ore., between Bend and Klamath Falls, also with two 5,000-hp. gas-engine-driven centrifugal units.

Initial design capacity of the Alberta-California pipeline at the international border will be 570 M.M.c.f.d.; maximum capability will be 608 M.M.c.f.d. At the Oregon-California border, initial design capacity will be 415 M.M.c.f.d.; maximum capability will be 454 M.M.c.f.d.

Future compressor requirements total 258,000 installed horsepower at 16 stations on the ANG, PGT, and PG&E sections. These compressor stations permit delivery of 800 M.M.c.f.d. to Pacific Gas & Electric Co. and 303 M.M.c.f.d. to El Paso Natural Gas Co.

DRILLING ROCK on a steep side hill along the Alberta Gas Trunk Line right-of-way near the Alberta-British Columbia border. Majestic Contractors, Ltd., crew is preparing shot holes for blasting. This scene looks west toward the approaches to Crowsnest Pass.

Storage facilitates steady-load operation

PG&E's present development of underground storage at McDonald Island gas field, a partially depleted producing field 40 miles east of Stockton, will enhance the high-load-factor operation of the Alberta-California line.

McDonald Island has 30 billion cubic of working storage capacity. Maximum withdrawal when the field is full will be 400 M.M.c.f.d. Withdrawal would be varied according to the requirements of the company's gas customers.

Advantages of using this storage will be had at a relatively low incremental cost. Gas can be injected in summer and withdrawn in winter to supply firm customers and handle interruptible loads rather than to curtail them.

Project delayed. The company is delaying the filling of the McDonald Island reservoir until the Alberta-California line will have been completed. All of the wells required to achieve a 400 M.M.c.f.d. withdrawal rate will not be drilled until after the McDonald reservoir has been filled after the Canadian line has been completed.

PG&E has another underground storage reservoir in Pleasant Creek field near the town of Winters in the Sacramento Valley. Pleasant Creek is close to the Alberta-California line. It has one-tenth of the storage capacity of McDonald Island and one-fifth of the withdrawal capability. Maximum withdrawal rate when Pleasant Creek is filled will be about 80 M.M.c.f.d.

Pleasant Creek is not as important for PG&E's Canadian gas program as McDonald Island.

Some gas has already been injected to restore the "cushion" or minimum pressure at McDonald Island. A new compressor plant is being completed there for injecting additional gas.

McDonald Island can be served through the existing compressor station at Brentwood, adjacent to major PG&E transmission lines. At McDonald Island a 2,000-hp. motor-driven compressor is being installed and 3,000 hp. will be added later in the field development. Brentwood has 3,000 hp. and an additional compressor of 2,250 hp. is scheduled. All the compressors will be capable of continuous operations at overloads of from 10 to 15%.

The gas now purchased by PG&E comes approximately 70% from El Paso Natural Gas Co. and 30% from California production.

Most California gas is dry and needs only to pass through separators for removal of liquids. It is purchased at load factors that vary from field to field, but average about 33% load factor based on peak deliverability.

Rio Vista gas field in California, discovered in 1938, can be fluctuated from 300 to a minimum of 50 M.M.c.f.d. to meet load requirements. Consequently, PG&E can fluctuate purchase of such dry gas with load requirements. It has been able to use dry gas in combination with curtailment of industrial use instead of large amounts of underground storage. Thus McDonald Island and Pleasant Creek have not been required for load requirements. PG&E will be entering a new phase of operation with use of underground storage in the near future.

California is an energy-short state. In PG&E gas territory, which now has a population of 6,210,000 and extends into 33 counties of California, demand for gas is estimated as increasing annually at the rate of 100 M.M.c.f.d.

Normal gas consumption is 1¼ billion cubic feet per day. Maximum sendout occurred on January 5, 1961, and exceeded 2 billion cubic feet. Total volume of gas distributed by PG&E during 1960 was 533.1 billion cubic feet, of which about 70% was purchased from El Paso Natural Gas Co. at the California-Arizona border and about 30% was California gas purchased from others.

When PG&E begins receiving 415 M.M.c.f.d. from the Alberta-California project, Canadian gas will amount to 22% of PG&E's total purchases.

In buying Canadian gas for the growing future demands, PG&E has a strategic advantage in concentrating acquisition efforts of its subsidiary, Alberta & Southern, in the Alberta producing areas generally west of those supplying Trans-Canada Pipe Lines, Ltd.

PG&E is reaching in several directions for sources of energy.

Nuclear power is expected to be competitive soon. PG&E is building

INSPECTING ENAMEL PRIMER of pipe being readied for installation in a Moyie River, Idaho, crossing are Ralph S. Nabors (left), general superintendent, and W. L. "Kelly" Langston, field representative, of Pacific Gas Transmission Co.

LOWERING-IN at Western Pipe Line, Inc., spread near Klamath Falls, Ore., for Pacific Gas Transmission Co. Pipe was delivered in 80-ft. joints coated internally and externally from the Sprague River construction field plant.

a 60,000-kw. atomic power plant at Eureka, Calif., for service in 1962. The second uranium fuel core holds definite promise of competitive power during its 3-year "burn-up" life, between 1965 and 1969.

Gas revenue up. Since 1929 when natural gas first came to San Francisco, the gas business grew to 34% of PG&E's total gross operating revenues.

California gas was sufficient through the 1940's. In 1949, PG&E built a 502-mile 34-in. line from a connection with El Paso Natural to Milpitas in the San Francisco area.

In reaching to Canada for more gas, the Alberta-California line has been planned so that it could pay out at the initial delivery rate of 415 M.M.c.f.d. To do this a compromise was necessary in selecting the diameter of 36 in. for the pipe with its lower investment cost rather than 40 in. with its attractive possibilities of lower future operating costs.

Price tag: $300,000,000

THE Alberta-California project was sponsored by Pacific Gas & Electric Co. with the collaboration of the Bechtel organization; Blyth & Co.; International Utilities Corp.; and Montana Power Co. International Utilities Corp. is the parent of the two major gas-distributing utilities of Alberta — Canadian Western Natural Gas Co., Ltd., and Northwestern Utilities, Ltd.

Functions of the Alberta-California project, other than those of supplying PG&E, include the following:

Montana Power Co.'s wholly owned subsidiary, Canadian-Montana Pipe Line Co., will purchase 30 M.M.c.f.d. of gas from Alberta & Southern at a point on the Alberta Gas Trunk Line System just north of the international boundary. Canadian-Montana will pipe it to the boundary near Carway, Alta., where it will be sold to Montana Power.

Westcoast Transmission Co., Ltd., will purchase gas from producers in Alberta for resale to El Paso Natural at the international boundary near Kingsgate, B. C. In Alberta it will be transported by Alberta Gas Trunk Line; in British Columbia by Alberta Natural Gas.

El Paso Natural purchases this gas from Westcoast at the international boundary, whence it will be transported by PGT to a point near Spokane and probably in the future to various delivery points in Idaho, Washington, and Oregon. El Paso is the sole supplier of natural gas to distributing companies in the Pacific Northwest area of the United States.

Furthermore, PGT will transport such additional volumes of gas for El Paso as may be requested from time to time up to a total of 303 M.M.c.f.d. from the international boundary to Pacific Northwest delivery points. By installation of additional compressor stations PGT's daily capacity for delivery to PG&E at the California border can be economically increased to 800 M.M.c.f. PGT does not contemplate making any sales in the three Pacific Northwest states from its own gas supply.

Capital Costs

Current (and tentative) estimates for the capital requirements of the Alberta-California pipeline system total about $308 million (U. S.), as follows:

Alberta Gas Trunk Line Co., Ltd.	$ 91,250,000
Alberta Natural Gas Co.	35,000,000
Pacific Gas Transmission Co.	124,069,000
Pacific Gas & Electric Co.	58,100,000
Total	$308,419,000

These figures are lower than original estimates to the National Energy Board of Canada and other regulatory agencies, but there have been some modifications of the original pipeline system in Alberta, and bids have been favorable to the operating companies. However, some contract awards have not yet been made and final cost estimates are not available.

To capital investment in the pipeline system proper must be added the very large investments being made in Alberta by producers. These were estimated to the National Energy Board at $140,000,000, as follows:

Development drilling	$ 27,000,000
Field gathering systems	23,000,000
Processing plants	90,000,000
Total	$140,000,000

Thus, total capital investment required to bring Alberta gas to northern and Central California will be on the order of $450,000,000.

Reserves. Alberta & Southern has Alberta government permits to export from Alberta approximately 4,106 M.M.c.f. during the 25-year term of its export permit. Presently proved reserves under contract or option to Alberta & Southern in 20 fields are estimated at 4,062 billion cubic feet—sufficient for the needs of the project at this stage. In addition to these proved reserves, contracted and optioned by Alberta & Southern, there are estimated proved reserves, in the 20-field supply area, amounting to 250 M.M.c.f. Additional reserves are expected through future extensions, development and discoveries.

The two Alberta government permits, for 4,106-billion-cubic-feet withdrawal in 25 years, authorize withdrawal from Alberta up to 489 M.M.c.f. in any 1 day and up to 164.2 billion cubic feet in any consecutive 12-month period. These permit volumes include gas to be resold to Canadian-Montana Pipe Line Co. The National Energy Board of Canada authorized Alberta & Southern to export up to 458.75 M.M.c.f. in any 1 day and up to 153.27 billion cubic feet in any consecutive 12-month period, and up to 3.826 trillion cubic feet during the 25-year term of the license. The Energy board issued Canadian-Montana a separate export license.

Gas prices. Base price of gas (in Canadian currency) is 14.50 cents per M.c.f. on July 1, 1961, increasing annually to 17.25 cents in 1968, and then increasing at 5-year intervals to reach 21 cents in 1983. The price after 1968 is subject to renegotiation at 5-year intervals.

Alberta & Southern has contracted with 51 producers for the purchase of gas from 20 fields in western Alberta.

Charges for gas. The price to be paid PG&E for gas delivered into its line from PGT at the Oregon-California border will represent an accumulation of costs including cost of gas plus various cost of service charges. These charges accumulate as the gas moves southward.

At the international border where PGT buys the gas from Alberta & Southern, the price of the gas paid by PGT is termed a cost-of-service charge composed of (1) the average field cost of gas to Alberta & Southern, (2) an allocation of Alberta & Southern's operating expenses, depreciation, amortization, taxes, and 7½% return on the base rate, (3) Alberta Trunk Line's charges including operating expenses plus an initial return on the base rate of 7½% (Trunk Line allocates costs between the two shippers—Alberta & Southern and Westcoast), (4) Alberta Natural's transport charge to Alberta & Southern including cost of service with a return on rate base of 7½%.

(During the third year of operation, the total of these charges is estimated to average 26.4 cents [U. S.] per M.c.f. at the contemplated 100% load factor, assuming an exchange rate of $1.03 U. S. for $1.00 Canadian.)

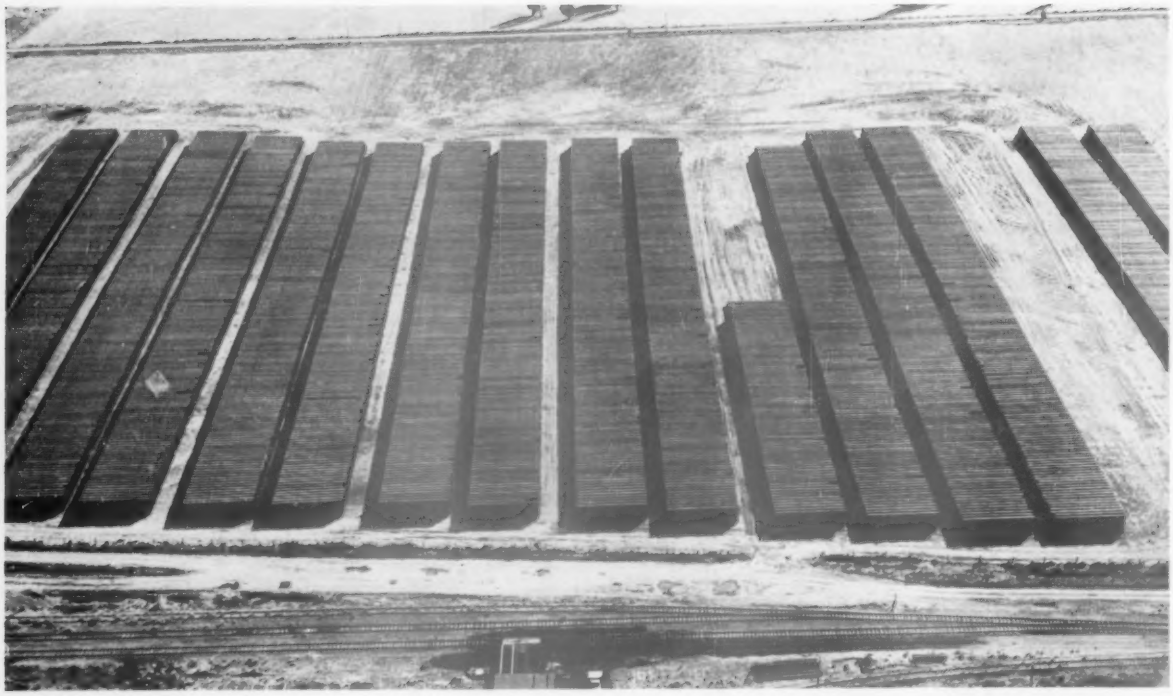
When the gas, reaching the Oregon-California border, is sold by PGT to PG&E it carries the above charges plus the PGT cost-of-service charge consisting of all operating charges (including cost of purchased gas), straight-line depreciation over the effective life of the Canadian permits, amortization, taxes, and a return on the rate base of 6¼%, less revenue received for transportation service rendered to El Paso Natural and miscellaneous operating revenue.

A cost-of-service charge computed in a similar manner is applied to deliveries by PGT to El Paso Natural.

Over the past 5 years PG&E's average day gas purchases have increased by approximately 400 M.M.c.f. per day. The company anticipates that the available supply of California gas will decrease. Additional supplies to offset this decline and to serve growing demand will come from El Paso Natural and the Alberta-California system.

In the preparation of this article assistance was given by James S. Moulton, Roscoe D. Smith, M. H. Chandler, and M. E. McWherter, of Pacific Gas & Electric Co.; C. P. Smith, F. W. McChesney, and Carl Whitmire, of Pacific Gas Transmission Co.; S. D. Bechtel, Jr., E. J. Mahoney, Jr., H. F. Waste, J. V. Chambers, and Michael Farley, of Bechtel Corp.; Harold C. Price and Don Barchus, of H. C. Price Co.; John Work and E. R. Wolfe, of Stanley-Bledsoe Corp., and A. J. Dougherty, of Kaiser Steep Corp.

PIPE GANG lining up 36-in. pipe for 5-mile kickoff section laid as part of the Alberta Gas Trunk Line program under the engineering direction of Canadian Bechtel, Ltd.



SEVENTY-FIVE MILES of 36-in. pipe ready to be double jointed at Sprague River, Ore., yard on Alberta-San Francisco pipeline. Nearly 10,000 40-ft. lengths, more than 33,000 tons, were in storage. This line is a major factor in . . .

California becoming nation's No. 1

WITH ONE major pipeline completed only recently, a second building, a third approved, and a fourth and fifth proposed, the supply of out-of-state natural gas for California could easily double.

As these projects materialize, they stand to make California the No. 1 gas consuming state of the United States.

These projects, their size and cost, emphasize the state's role as one of the world's great natural-gas markets. Built, building, and proposed projects add up to these very impressive figures:

Miles of transmission line, 13,700;

Cost of lines and facilities, $2,500,000,000;

Capacity per day, 3,900,000,000 cu. ft.;

Value of daily deliveries, $1,500,000.

Unusual aspects. In addition to making California the nation's No. 1 market, these developments would be marked by other unusual aspects:

- They end California's dependence on a single out-of-state supplier and may increase the number to five;
- They will give the state the widest base of supply of any single natural-gas market;
- They will tend to stabilize the price of natural gas at the state's borders;
- They include the building of the world's largest-diameter long-distance transmission line;
- They include what may be the longest term contract at a fixed price ever concluded, and
- They will bring about a further expansion of what is already the industry's most far-flung one-company system.

Expansion set. The lines built, building, or proposed are generally complete projects. In addition, there are major expansion projects to existing facilities that would add another 500 M.M.c.f. to California's daily quota.

California's gas now comes primarily from Texas' Permian basin and Panhandle and from New Mexico's San Juan basin. If and when proposed projects are completed, gas for California will come from South Texas fields, from new sources in the Rockies, from a number of fields in Alberta, Canada, and from northeastern Mexico.

Others Enter Picture

Until less than a year ago, California had a single out-of-state supplier, El Paso Natural Gas Co. El Paso, because of its daring and foresight, had a monopoly for a dozen years. This daring and foresight paid off handsomely . . . El Paso grew an incredible 50 times in less than 15 years.

El Paso's monopoly was ended last year when Transwestern Pipeline Co. became the state's second supplier. Transwestern's system also originates in the vast West

BY JOHN P. O'DONNELL
Assistant Pipeline Editor

Pipeline projects building and proposed will double present supply. They're a $2.5 billion investment in 13,700 miles of line to deliver 3.9 billion cubic feet per day

gas market

EXPANDING NETWORK of pipelines will give California the most varied and far-flung sources of supply of any single natural-gas market.

Texas and Texas Panhandle fields.

The monopoly will be further diluted this year when the Alberta-San Francisco line, sponsored by Pacific Gas & Electric Co., is completed. This 1,400-mile system will add the tremendous gas reserves of Central Alberta to California and give the state its first foreign source of gas.

Two joint efforts are vying to be next in line. El Paso has joined with Colorado Interstate Gas Co. in one and Tennessee Gas Transmission Co. and Petroleos Mexicanos, the Mexican Government petroleum agency, in the other.

FPC approved. The 1,000-mile El Paso-Colorado Interstate project has Federal Power Commission approval and the conditional approval of the California Public Utilities Commission. This line is now scheduled for construction in 1963 unless it is needed earlier. It would deliver Texas, Rocky Mountain, and Hugoton gas to California.

The 1,600-mile Tennessee-Pemex system would originate in South Texas, stretch across northern Mexico, and enter California near Mexicali. Most of its supply would come from south Texas and the rest from Mexico's Reynosa area.

Still another entry is International Gas Co. which has been working for a number of years to deliver Mexican gas to California. Its source would be the Reynosa area with Los Angeles as the destination.

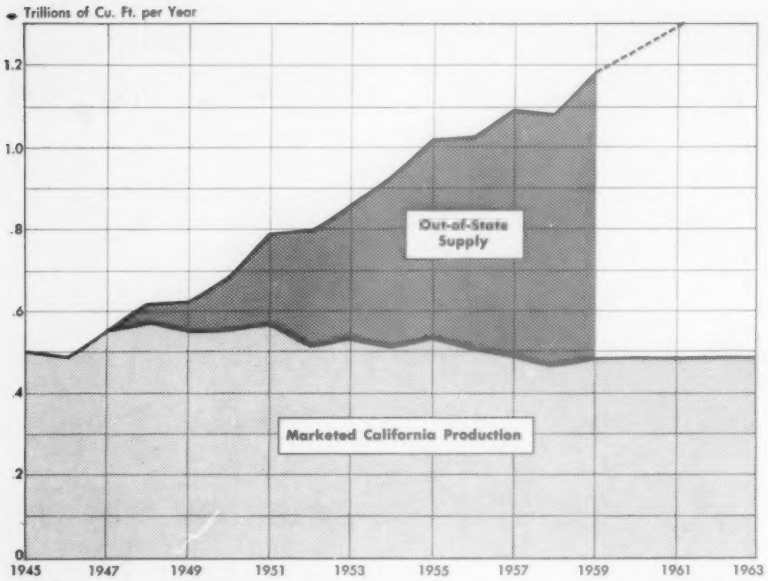
In addition to these complete projects, the two operating systems are prepared to expand their facilities. El Paso has asked FPC for permission to increase its deliveries by 200 million cubic feet per day.

To add source. Part of its expansion program calls for the construction of a 228-mile, 30-in. pipeline from its Sonora station, the most easterly point of its present system, to Coquat in Live Oaks County, deep in South Texas. This would add a tremendously important new source of supply to the El Paso system and also to California. It will add to its stature as the most far-flung single-company system in existence.

Transwestern inaugurated deliveries last November at the rate of 300 M.M.c.f.d. Its main line can handle 640 M.M.c.f.d. with the addition of compressor capacity and it is aiming to attain that figure.

Wide Base of Supply

When this widespread system is completed, California will have a vastly greater variety of sources of



CALIFORNIA'S CONSUMPTION of natural gas has more than doubled in 15 years and imports now supply more than 60% of demand.

supply than any other major market. The high-consuming areas of the Northeast and Midwest are now largely dependent on Texas, Louisiana, Oklahoma, and Kansas.

California will share all these except Louisiana and, in addition, will draw from the Rocky Mountains, Canada, and Mexico. This will give it access to most of the main producing areas of North America.

Texas supply. Texas, with its 120 trillion cubic feet of reserves, is the most important single source. New Mexico, Kansas, and Oklahoma each has reserves of 16 to 20 trillion cubic feet. Alberta's reserves have been variously estimated from 60 to 102 trillion cubic feet.

The very volume and variety of California's present and prospective sources of supply assure its continued growth. They provide one good reason why it will become, in time, the No. 1 U. S. market.

Another good reason is the state's steadily and rapidly increasing population. It is now up to about 16 million and has more than doubled in the last 20 years. Its rate of growth has been 4% per year, well above the national average.

Texas, with its huge industrial load and ample sources of supply within its own borders, is now the largest natural-gas market. Its consumption in 1959 was approximately 20% greater than that of California. The latter's rate of growth, however, is faster and, it appears certain California will soon overtake Texas.

Demand high. California, alone, consumes more gas than the Middle Atlantic states combined, more than half as much as the highly industrialized, thickly populated East North Central states of Illinois, Indiana, Michigan, Ohio, and Wisconsin, and as much as the seven states that make up the West North Central area.

All of these regions are supplied by anywhere from 4 to 10 major natural-gas-pipeline companies. Until last year California was supplied by one. This situation makes it clear why others are interested in sharing in the California market.

A market of this size is big business. Out-of-state deliveries to California averaged 2 billion cubic feet per day in 1959. At a price of slightly more than 30 cents per M.c.f., this business was worth then about $650,000 per day.

Since El Paso began shipping gas to California in late 1947, the price has approximately doubled and the volume of imports has grown more than 10 times. Prices will rise somewhat more and volume will increase greatly. By the end of this year it will be a million-dollar-a-day market.

Price trend. The present trend of prices indicates that they will nearly double in the next 15 years. However, the trend should taper off long before that and it is to be doubted that prices will reach the indicated 60 cents per M.c.f.

The average price of El Paso gas going into California is 33.38 cents per M.c.f. The price via Transwest-

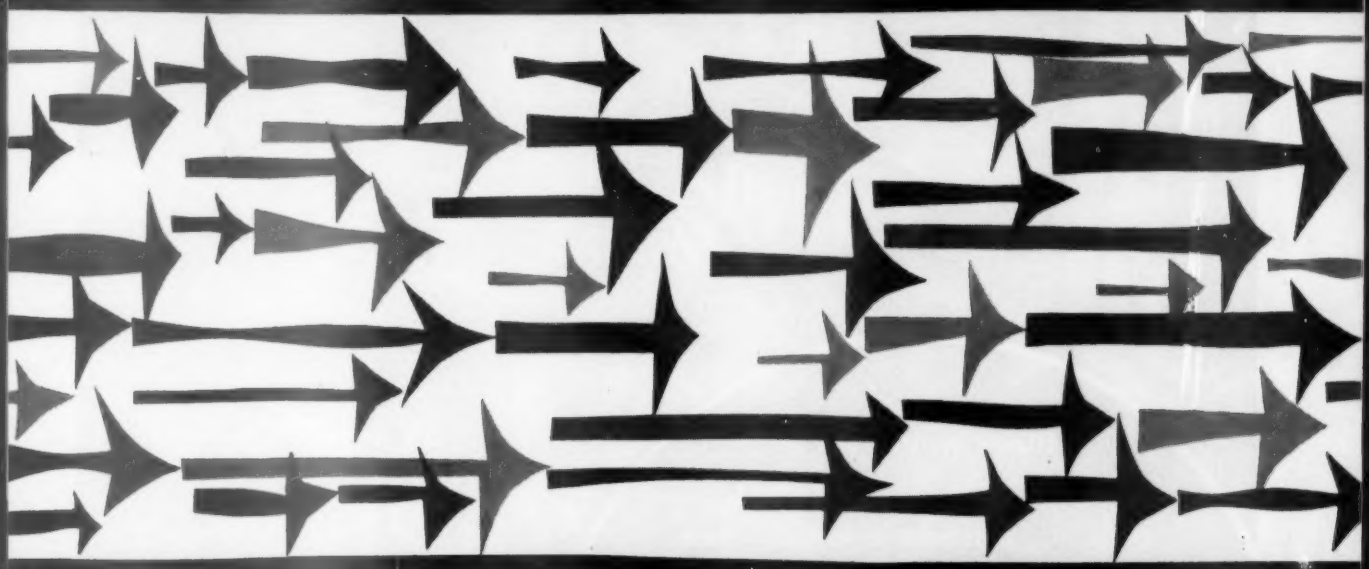
NATURAL-GAS PRODUCTION, IMPORTATION, AND CONSUMPTION IN CALIFORNIA, YEARS 1945-1959

(In millions of cubic feet)

Year	(1) Total California gas produced and marketed*	(2) Gas imports from out of state	(3) Deductions: Transmission losses and unaccounted for	(4) Deductions: Net to storage	(5) Total consumption
1945	502,442	.....	(†)	(†)	502,442
1946	487,904	.....	(†)	(†)	487,904
1947	560,510	3,490	‡17,612	−1,994	548,382
1948	570,954	65,560	‡21,329	−2,430	617,615
1949	550,903	94,009	‡22,805	2,874	619,323
1950	558,398	148,039	‡18,654	3,859	683,924
1951	566,751	243,749	‡27,605	−4,953	787,848
1952	517,450	297,674	‡23,267	− 663	792,520
1953	531,346	357,108	‡25,985	276	862,243
1954	507,289	460,240	‡29,221	4,374	933,934
1955	538,178	507,157	23,683	1,257	1,020,395
1956	504,458	551,370	27,198	7,628	1,021,002
1957	492,338	634,451	22,315	13,238	1,091,236
1958	465,582	642,026	11,783	16,970	1,078,855
1959	485,655	729,927	27,540	7,711	1,180,331

*Excludes field use and loss and repressuring. †Not available but assumed to be negligible. ‡Derived from columns (1) + (2) − (4) − (5).

Source: U. S. Bureau of Mines, Minerals Yearbook and chapter preprints therefrom on "Natural Gas, Years 1945-1959."



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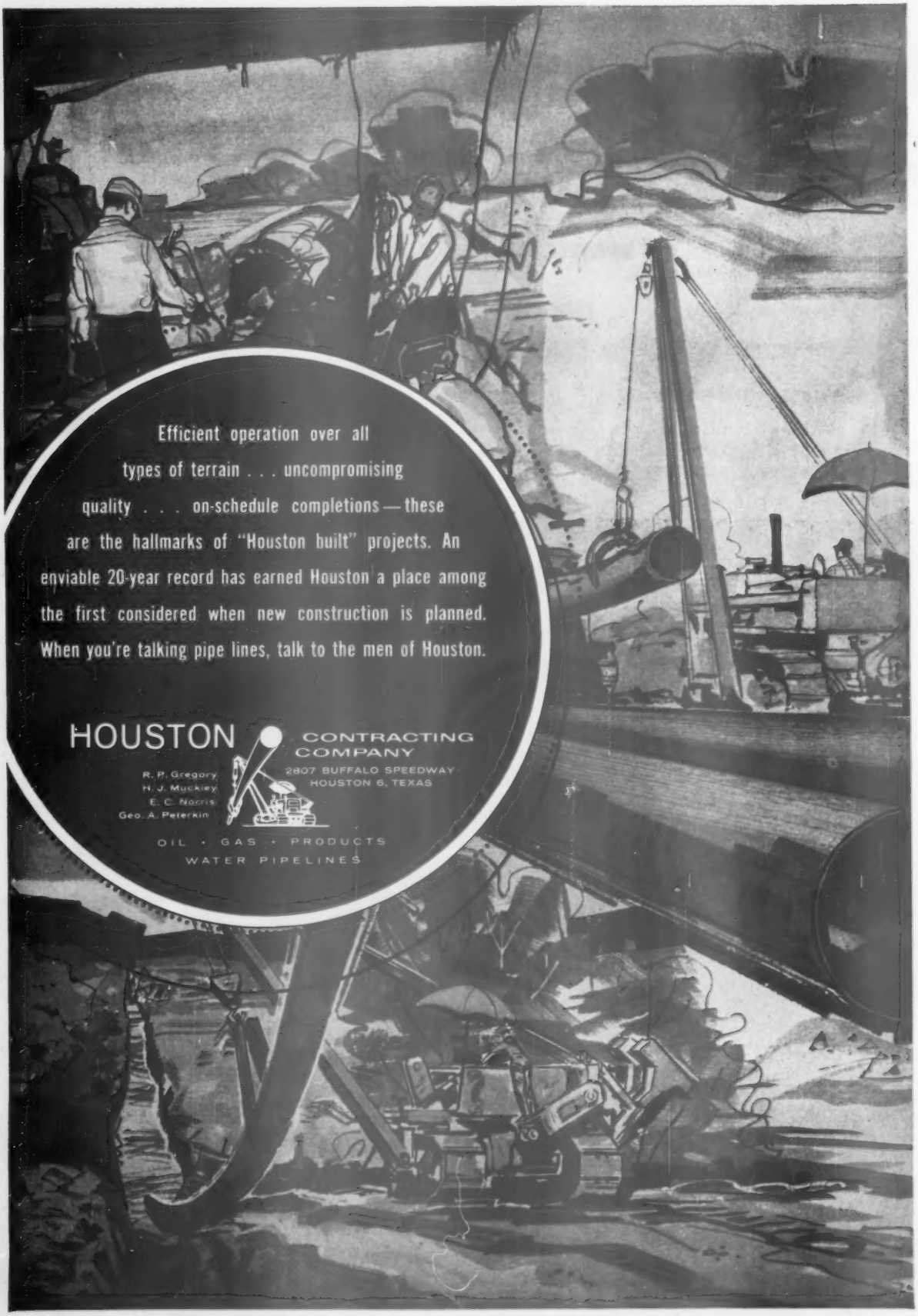
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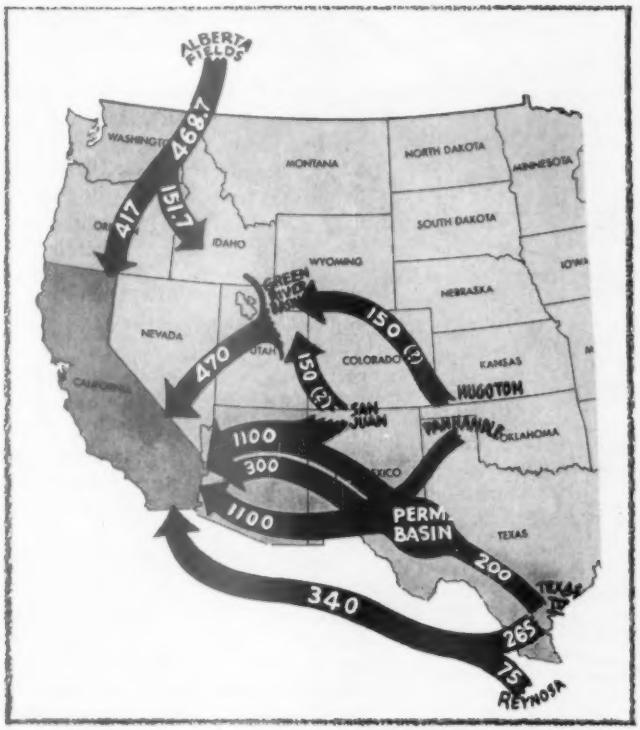
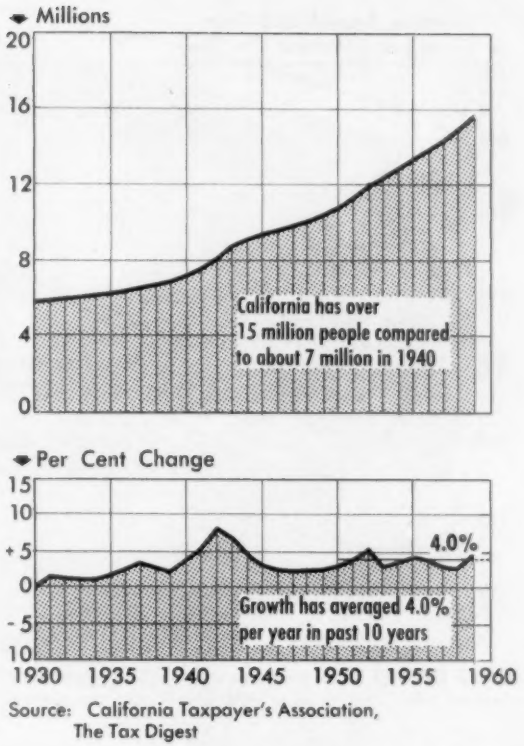


FLOW OF GAS to California will double as proposed projects materialize. Seven states, Canada, and Mexico among ultimate sources.



Source: California Taxpayer's Association, The Tax Digest

POPULATION HAS DOUBLED in California in the past 20 years and its rate of growth outpaces that of the rest of the U. S.

ern is 42 cents at the border and the initial cost via the Alberta-San Francisco line will be 38.7 cents. El Paso-Colorado Interstate would begin deliveries at today's average, rising to 40 cents in 1962. The price via Tennessee-Pemex would not exceed 45 cents for the 20-year life of the agreement.

There are two unusual aspects to Tennessee-Pemex proposal. One is the cost of gas to Southern California Edison which is guaranteed not to exceed an over-all average of 45 cents based on 100% load factor over the 20-year period. It has been said that "no long term supply contract for such volumes has ever been offered before by any fuel supplier."

Direct sale. The other is the fact that the major volume to be handled by the system would be a direct sale from Humble Oil & Refining Co. in Texas to Southern California Edison in California. It has been estimated that over the 20 years Humble would supply 1.9 trillion cubic feet. If the price averaged 45 cents, this would be a single contract for more than $850,000,000.

Investments Are Huge

El Paso Natural Gas has invested more than $1.6 billion in the facilities that comprise its system. Some has gone to supply the markets it serves in Texas, New Mexico, and Arizona. It is estimated that a full 80% of its investment has gone into serving the California market. On this basis, El Paso has spent almost $1.3 billion to supply California.

It's a huge ante but one that paid off very well. In 1945, El Paso's total business was just under $9,000,000. In 1959, it was over $450,000,000.

Huge growth. Since its first line to California began operating in 1947, El Paso has undergone eight major expansions. It has built the equivalent of five pipelines to California in two systems.

The southern system originates in the Permian basin of Texas and terminates near Blythe, Calif., on the Colorado River. It consists mainly of two lines, one 26-in. and the other 30-in.

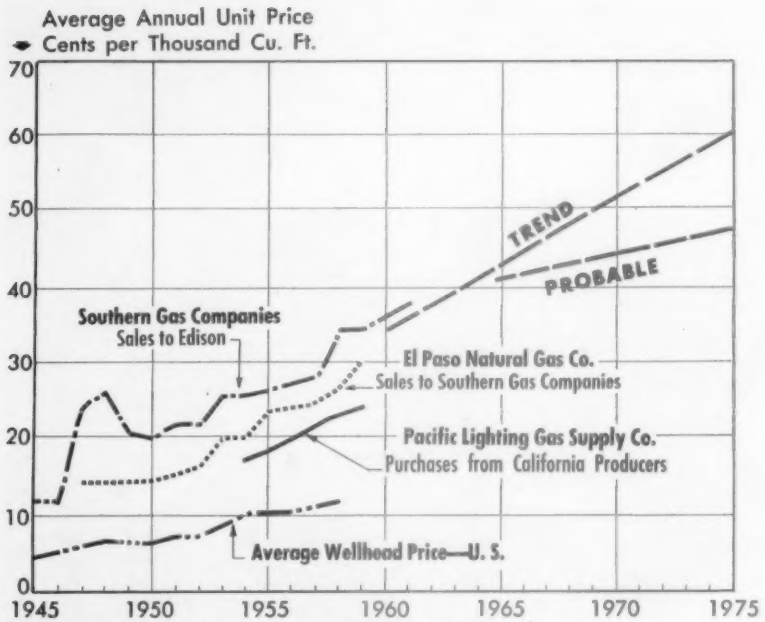
Its northern system originates in the San Juan basin of northern New Mexico and southern Colorado. It consists mainly of three lines, 24, 30, and 35-in. These lines terminate at Topock, Ariz., also on the Colorado.

The systems are fully integrated by connecting lines. On the east they are interconnected by a partially looped 30-in. line from Plains, Tex., to Gallup, N. M. In western Arizona there are two crossover lines, one 20-in. and the other 30-in.

El Paso merged with Pacific Northwest Pipeline Corp. in 1959 and began operating its system in 1960. This 22 and 26-in. line runs from Sumas on the Washington-British Columbia border to the San Juan basin.

Total Reserves High

The Northwest system connects with Westcoast Transmission Co. at Sumas where El Paso takes 300 M.M.c.f.d. from the British Columbia and western Alberta fields which Westcoast serves. It will also take 150 M.M.c.f.d. from the Pacific Gas Transmission at Spokane, Wash., when the Alberta-San Fran-



Source: 1945-60 data, Southern California Edison Co.

PRICES OF GAS have gone up steadily but lower rate of increase is in prospect. Upward trends for in-state and out-of-state gas parallel.

cisco line will start up operations.

El Paso, thus, will be able to draw on major natural-gas-producing areas from Alberta and British Columbia to the Texas Gulf Coast when its present expansion plans are realized. Much of this will be available to California.

Some of the Canadian gas will be supplied by El Paso-owned operations. Its producing venture in British Columbia with Western Natural Gas Co. has been highly successful. At the end of 1959, El Paso estimated that it owned gas reserves of 12.8 trillion cubic feet and had 27.7 trillion cubic feet under contract. Thus it controlled, at that time, 40.5 trillion cubic feet, enough in itself to supply today's California market for 20 years.

Demand met. These facilities easily enable El Paso to meet its present certificated supply for California, 2,050 M.M.c.f.d. Of this 1,030 M.M.c.f.d. is for Southern California Gas Co. and 1,025 M.M.c.f.d. for Pacific Gas & Electric Co.

Southern California operates three 30-in. pipelines from the Colorado border to Los Angeles, one originating at Topock and two at Blythe. Pacific Gas & Electric has two 34-in. pipelines to San Francisco, both originating at Topock.

Transwestern Pipe Line Co., California's second supplier, spent $191,000,000 on its system. It commenced deliveries to Pacific Gas Lighting Co. at the initial contract rate of 300 M.M.c.f.d. on November 1, 1960.

New factor added. Transwestern is now partially owned by Northern Natural Gas Co. which recently bought the 16% of Transwestern stock that had been held by Monterey Oil Co. Northern is a major supplier of gas from Texas, Kansas, and Oklahoma to the Midwest. Its association with Transwestern brings another company indirectly into the California supply picture.

Main line of the Transwestern system is 644 miles of 30-in. line from a point just east of Roswell, N. M., to Topock. It closely parallels El Paso's northern system.

East of Roswell it divides into two 24-in. laterals, one extending 288 miles into the Texas Panhandle and the other 164 miles into West Texas. Extensive gathering systems both in the Panhandle, 643 miles, and in West Texas, 219 miles, are still being built. The entire Transwestern system plus Pacific Gas Lighting's 231-mile line to Los Angeles adds up to almost 2,300 miles of pipeline.

Highly automated. This ultramodern, highly automated line began operations with only four mainline compressor stations. Ultimately it will have nine main line stations with 126,000 hp. which will boost its capacity to 640 M.M.c.f.d.

Biggest Line Building

The Alberta-San Francisco line, more fully described elsewhere in this issue, will cost $340,000,000. One of its most distinctive features is its size. Some 1,236 miles of the 1,400-mile system will be 36-in. diameter. It will be the largest-diameter long-distance pipeline ever built.

Pacific Gas & Electric will build and operate the 291-mile section from the Oregon border to San Francisco. Three other companies are building the remainder: Pacific Gas Transmission Co., 611 miles to the Canadian border; Alberta Natural Gas, 108 miles in British Columbia, and Alberta Gas Trunkline, 351 miles of main line and 74 miles of laterals in Alberta.

Proven reserves. Proven reserves which this line will have primary access to are estimated at as much as 5 trillion cubic feet. This figure will certainly grow as demand stimulates development.

Initial capacity of the Alberta-San Francisco line will be 596.7 M.M.c.f.d. and the ultimate capacity, 800 M.M.c.f.d. All but 30 million cubic feet of the original volume will contribute to the California supply. Pacific Gas & Electric will take 417 M.M.c.f.d. and 151.7 M.M.c.f.d. will be part of the supply for the El Paso-Colorado Interstate project. The other 30 M.M.c.f.d. will go to the Montana Power Co. via a 16-in. lateral to Carway.

The El Paso-Colorado Interstate "Rock Springs" project plus the California line from Arizona to Los Angeles would add up to $177,000,000. Colorado Interstate would invest $92,000,000, El Paso, $60,000,000, and Southern California Gas Co. and Southern Counties Gas Co., $25,000,000.

Involved plan. Colorado Interstate's construction entails a 109-

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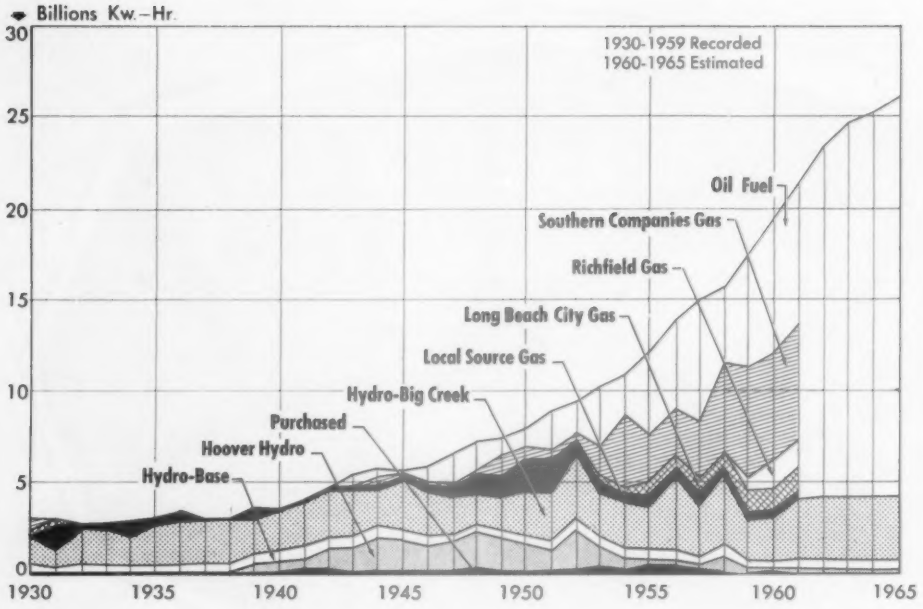

GAS is growing energy source for generation of electricity by leading California utility. Two-thirds of supply is from out of state.

mile, 26-in. line from the Texas Panhandle to southeastern Colorado, a 136-mile, 34-in. line from there to Pueblo, a 107-mile, 30-in. line from Pueblo to Denver, and a 155-mile, 34-in. line from Rock Springs, Wyo., to Provo, Utah.

El Paso's portion is a 394-mile, 34-in. line from Provo to the California border at Ivanpah, southwest of Las Vegas. The California companies would build a 93-mile, 34-in. line from Ivanpah to Newberry. This system could be supplied from the Texas Panhandle, El Paso's northwest system, notably Big Piney field of Wyoming, and with the Canadian gas El Paso will take on at Spokane. It could, eventually, also get supplies from Westcoast Transmission.

Mexican gas would become a part of California's supply if the Tennessee Gas Transmission Co.-Petroleos Mexicanos project materializes. Initial capacity would be 340 M.M.c.f.d., 75 million of which would come from Mexico's Reynosa field and 365 million from South Texas.

Cost is high. This 1,592-mile system would cost $225,400,000: $11,000,000 for the Texas portion, $165,000,000 for the line through Mexico, and $49,400,000 for the line from Mexicali to Los Angeles plus laterals to California Edison plants.

The Texas section would be a 100-mile, 30-in. line from the King Ranch to Mexico and the Mexico section, to be owned by Pemex, a 1,200-mile, 34-in. line from Reynosa to Mexicali. A 224-mile, 34-in. line would carry the gas to Los Angeles. Five Edison plants would be served en route through 54 miles of 24-in. laterals and 14 miles of 20-in. laterals.

California Edison would be the lone U. S. customer. It has been buying gas, some 60 M.M.c.f. per year, on an interruptible basis from Southern Counties and Southern California Gas companies. It would like to have a constant assured supply and would take, in time, as much as 459 M.M.c.f.d. to meet its growing generation needs.

Package deal. This proposal would tie into a neat package one of the country's great sources of gas, Humble Oil & Refining Co.'s King Ranch area, and one of its largest industrial customers, Southern California Edison.

One of its strong points is that it would add an entirely new source of supply for California and one of considerable magnitude. Estimated reserves of Texas District 4 in which the King Ranch is located are 9 trillion cubic feet. Those of the Reynosa area are estimated presently at 3 trillion cubic feet with ample area for future development.

Another favorable factor is the Los Angeles County Air Pollution Control Board's regulation prohibiting the burning of fuel oil with a sulfur content of more than 0.5% from May 1 to November 1. Fuel oil has been a major source of energy for Edison's generating plants. The cost of treating to make it usable the year-round is regarded as prohibitive.

Foes' position. Strongest opposition to the Tennessee-Pemex proposal is that it would reduce the load of existing systems which depend on Southern California Edison's needs to maintain their off-peak volume. This would, they contend, up the costs of El Paso and Transwestern gas to residential consumers.

The Tennessee-Pemex proposal has been the subject of two hearings before the California Public Utilities Commission and its fate has yet to be established. The proposal of International Gas Co., a Los Angeles-based enterprise, has yet to reach the hearing stage.

Its backers have been quietly at work for a number of years to develop a supply of Mexican gas for the California market. Its principal source would be the Reynosa area but its route would lie south of the Tennessee-Pemex route. This would enable it to serve a number of Mexican communities en route to California.

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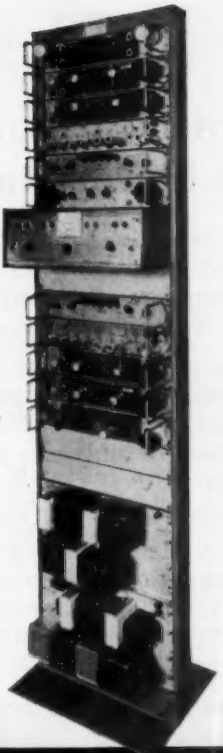

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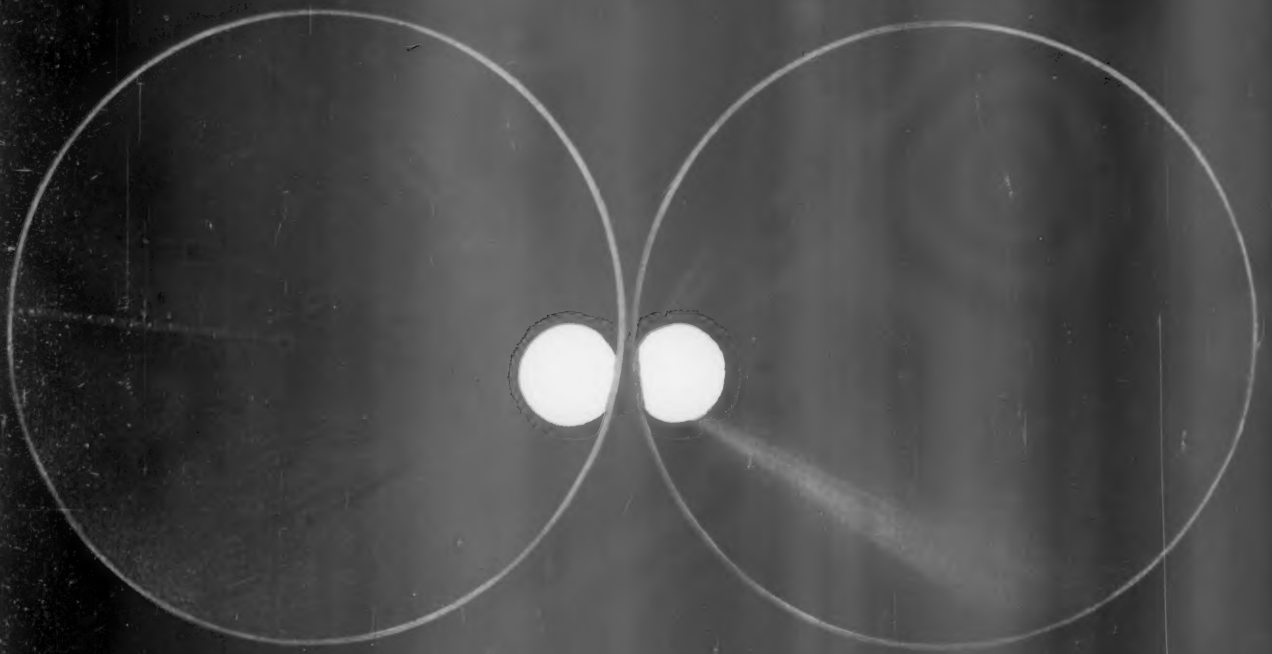

At the right above is one section of a 30" line pipe internally coated with Napko's Epoxycote Pipeliner, the first amine-cured epoxy resin specifically formulated for gas line transmission. Epoxycote Pipeliner has now been used in all parts of the country with equally good results, providing a surface smoothness that increases line-flow efficiency and reduces maintenance costs. The uncoated section at the left shows severe pitting that can occur during transit and storage and that can be prevented by Epoxycote Pipeliner.

6% INCREASE IN PIPELINE FLOW EFFICIENCY WITH NAPKO EPOXYCOTE PIPELINER!

Extra Thru-Put and Cleaner Gas at Lower Maintenance Cost

Throughout the United States pipeline engineers report that lines internally coated with Napko's Epoxycote Pipeliner show record improvement in thru-put, product purity, and line maintenance economy.

Studies indicate that the walls of coated pipe have an average relative roughness of 280 micro-inches, compared to an average of 700 micro-inches in unweathered mill pipe. Weathered pipe in a mild environment in as little as 60 days can attain a surface roughness up to 1500 micro-inches (an additional 2-5% loss in efficiency).

Leading internal coating specialists such as L. C. Russell Company, Rosson Richards Company, H. C. Price Company and Stanley-Bledsoe Corporation testify to the dependable behavior of Epoxycote in both application and finished film properties.

For complete details and published project references write to

TESTED FEATURES OF EPOXYCOTE PIPELINER

PREVENTS PITTING IN TRANSIT & STORAGE: In industrial atmospheres, humid regions, and particularly marine areas, severe pitting can occur in uncoated pipe. Epoxycote moisture and chemical resistance virtually puts an end to pitting.

REDUCED CLEAN-UP EXPENSE: Pigging a new line to remove loose rust and millscale can cost up to 17¢ a foot, but after cleaning and lining with Epoxycote, a single plug is usually sufficient. Napko Epoxycote has maximum hardness to help prevent pigging damage.

CLEANER LINES & GAS: All rust and loose millscale can not be removed from uncoated pipe by pigging. Prior lining with Epoxycote minimizes load on scrubbers, with the cleaner gas ultimately reducing service of consumer gas appliances by the gas distributing company.

INCREASED CAPACITY: Friction losses are reduced by smoother internal surface.

PREVENTS INTERNAL CORROSION: Minute traces of moisture, oxygen, and such contaminants as hydrogen sulfide, accelerate pitting of uncoated pipe. Epoxycote Pipeliner is chemically resistant to the corrosive impurities of natural gas, insuring maximum protection of the line and the product.

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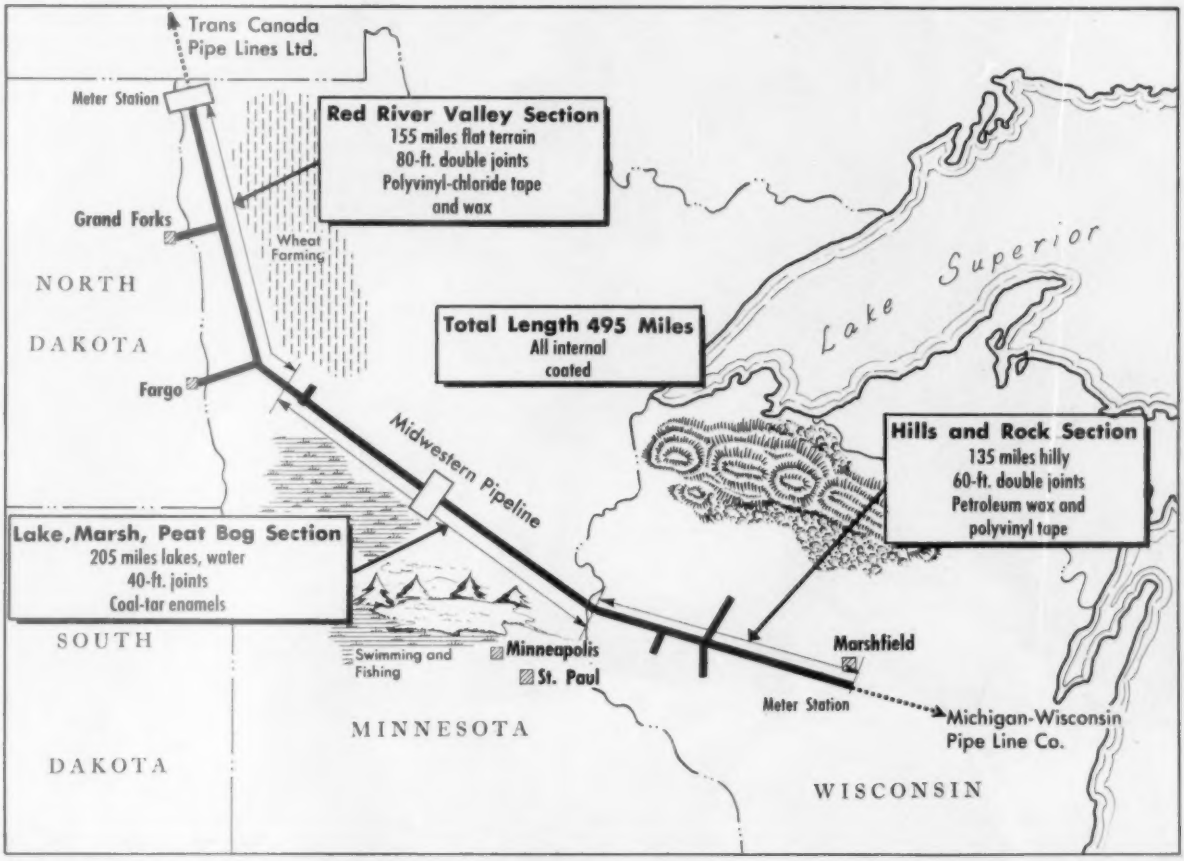

WHEAT FARMS, marshes, peat bogs, lake country and hills are encountered on the 495-mile route from the Canadian border through Minnesota and into Wisconsin. Because of these variations . . .

Methods are matched with terrain

to speed building of Midwestern's northern line

CLOSE MATCHING of pipeline to terrain exemplifies Midwestern Gas Transmission Co.'s new 495-mile, 24-in.-diameter line from the Minnesota-Canadian border to Marshfield, Wis.

- The line crosses three distinctly different terrains. It matches these conditions by combinations of double jointing, external wrapping, and field techniques.
- It has 80-ft. double joints in flat terrain, 60-ft. double joints in sand, hills, and rock, and 40-ft. joints in marsh areas.
- Three external coatings protect the line, depending on terrain: polyvinyl chloride tape, petroleum wax, and high-temperature and semiplasticized coal-tar enamels.
- Entire length is coated internally with epoxy resin paint.

BY H. C. BOZEMAN
Journal Staff

Midwestern, a subsidiary of Tennessee Gas Transmission Co., built the $52 million line in a little over 6 months after approval. Preliminary field work began April 4, 1960, and service commenced October 14, 1960. Throughput capacity is 204 M.M.c.f.d.

Favorable weather conditions, experienced crews, and division of the line into eight segments helped speed construction.

Midwestern developed its construction techniques from experiences with its southern line from Portland, Tenn., to near Joliet, Ill.[1] It planned double jointing and external wrapping compatible with the terrain that the northern line would cross.

Starting at the Canadian border, the first 155 miles cross flat country with dense clay soil, the middle 205 miles pass through lakes, marshes, and peat bogs, and the last 135 miles go over rolling hills and rock. Each section will be discussed in turn.

The line makes dual crossings at the Mississippi, St. Croix, and Chippewa rivers.

Red River Valley Section

The line originates at the Canadian border about 12 miles north

"... pacing the pipeline construction industry
for more than a quarter century"

price tower

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of Hallock, Minn. Gas is purchased from Trans Canada Pipe Lines, Ltd. Metering facilities are on the Canadian side.

It parallels the Red River at distances from 5 to 12 miles east of the river for the first 155 miles from Canada to the Becker-Clay County, Minnesota, line. Wheat farming predominates and there is little other vegetation. The land is flat and of dense clay, but with areas of high soil stress because of high humus content.

Midwestern placed the 40-ft. joints from the mill at sites near Donaldson, Crookston, and Ada, Minn., for internal coating and double jointing. Each location processed about 50 miles of pipe.

At the three sites 40-ft. joints first were coated internally with epoxy resin paint and then welded automatically into 80-ft. double joints. Double jointing in 80-ft. lengths speeded laying in the flat terrain and saved welding time.

Ditching was conventional. For all practical purposes, bending machines were needed only where the line crossed drainage ditches and county roads.

External wrapping is polyvinyl chloride tape with a butyl-rubber intersurface. The outside wrap is kraft paper. High-soil-stress areas here led to the use of tape. The same equipment can apply both tape and wax. These wraps require less equipment, personnel, and time than hot-applied wraps.

Lake, Marsh, and Peat Bog Section

The middle section covers a distance of about 205 miles from Becker-Clay county line to the St. Croix River. Predominate terrain features are lakes, marshes, and peat bogs.

Midwestern delivered the pipe to right-of-way in 40-ft. joints already coated internally. Epoxy resin internal coating was applied near the pipe mill under separate contracts.

Ditching was conventional where soil was firm, but soft areas required back hoes, draglines, and blasting. Trees and shrubs are predominate right-of-way vegetation.

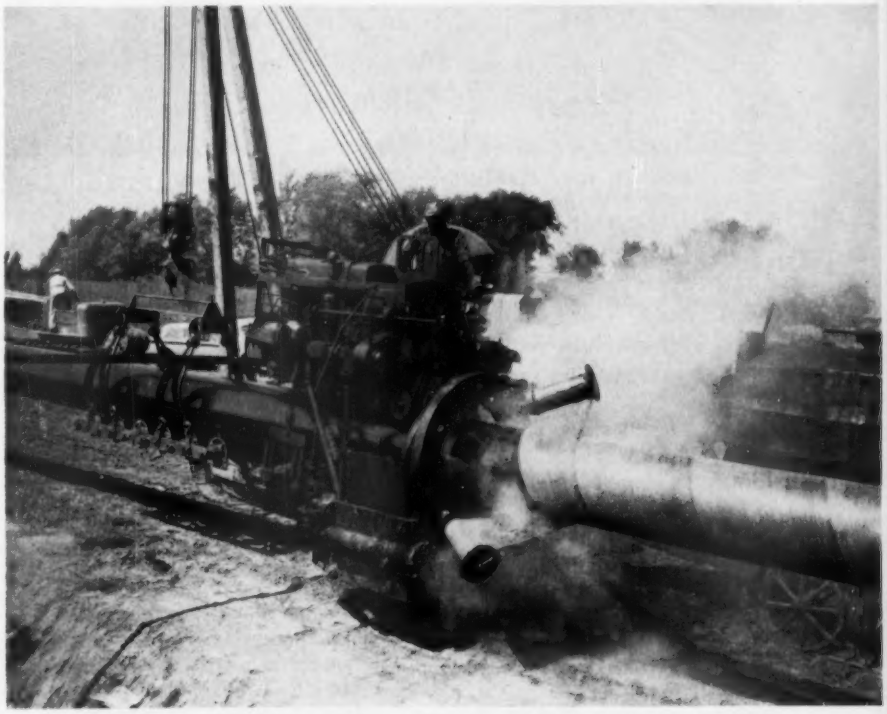
Pipe was pushed into the ditch at water and soft ground locations. Bolt-on concrete weights sank the pipe into the ditch.

Weights averaged 5,000 lb. and over 6,000 weights were used. The concrete, consisting of magnetite aggregate and sand, weighs about 210 lb. per cu. ft. Weights were made adjacent to right-of-way.

External coatings are two kinds of coal-tar enamels. High-temperature coal-tar enamels, applied for 20 miles downstream of compressor-station sites along this section, total 72.9 miles. The remainder is semiplasticized coal-tar enamel. Outer wrap of both is impregnated glass fiber.

Conventional hot-application equipment and techniques applied these coatings. Where there are

PETROLEUM WAX, 1/32-in. thick, with a 2-mil polyvinylidene chloride film wrap and 80-lb. laminated kraft paper outer wrap protects about 115 miles of main line in hills and rock country.



HIGH-TEMPERATURE COAL-TAR ENAMEL with glass-fiber outer wrap protects 72.9 miles of main line downstream of compressor stations. Semiplasticized coal-tar enamel covers 142.1 miles of main line.

HILLS COMBINED WITH MARSHES are encountered as the line approaches the St. Croix River from the Minnesota side.

weights, coal-tar enamels perform better than other external coatings, Midwestern says.

Hill and Rock Section

The last 135 miles are from the St. Croix River to the metering station, 5 miles south of Marshfield, where gas is delivered to Michigan Wisconsin Pipes Line Co.

Pipe was delivered to the right-of-way in 60-ft. double joints already coated internally with epoxy resin paint. Internal coating was applied near the mill. Ditching and clearing were conventional for hill and rock country.

Midwestern applied two kinds of external wrapping. Petroleum wax, 1/32 in. thick, with polyvinylidene chloride film wrap covers 115 miles of main line. Polyvinyl chloride tape protects another 20 miles of line downstream of a future compressor-station site in the section.

Mounds of rock-free soil about 20 ft. apart in the ditch pad the pipe in rocky and hard-clay areas.

Internal coating. Elimination of oxidation between mill and laying operations is one advantage of internal coating. Also, it increases flow efficiency and helps line cleaning during startup.

Midwestern went a step further to minimize line-cleaning problems. During stringing operations every joint of pipe was placed on skids. This kept much mud out that normally enters the pipe.

Swabbing, prior to pickup by the pipe gang, removed any additional dust and soil accumulations. The line was much easier to clean after construction and Midwestern found the extra care fully justified. A minimum of two pigs in each section made final cleanup.

Laterals. The line has six laterals totaling 54.76 miles. They serve: Grand Forks and Fargo, N. D.; Detroit Lakes, Moorhead, Ada, and Dilworth, Minn.; and Menomonie, Chippewa Falls, and Eau Claire, Wis.

Laterals are not coated internally because it was not justified economically and flow efficiency did not pose a bothersome problem.

Laterals in Minnesota are wrapped with polyvinyl chloride tape. Wisconsin laterals are mill coated with coal-tar enamel and white, unsaturated asbestos-felt outer wrap. The white color helped prevent coating degradation during stockpiling.

Compressor Stations

Two 5,100-hp. compressor stations, Hallock and Staples, Minn., are in service. Six additional sites have been purchased, also.

Each station has three 1,700-hp. reciprocating two-cycle, gas-engine prime movers.

Compressors are unitized installations typical of several stations built in 1959 by Tennessee Gas. Each compressor has a control panel which has push-button sequential start-and-stop switches and valve-operator push buttons.[2]

Communication is over leased telephone lines. Telemetering facilities are similar to those of the Tennessee Gas system. Dispatching is directed from the terminus of Midwestern's southern line near Joliet, Ill.

Station valves are full-opening ball-type valves. Control is tied into the station's emergency shutdown system.

Main-line valves are spaced about 20 miles apart. These full-opening gate valves operate by manual operators actuating hydraulic cylinders.

All pipe exposed to atmospheric temperatures is made from low-temperature steel (Charpy test 15 ft.-lb. impact strength at −50° F.). Winter temperatures can drop as low as −30° F. in Minnesota and Wisconsin.

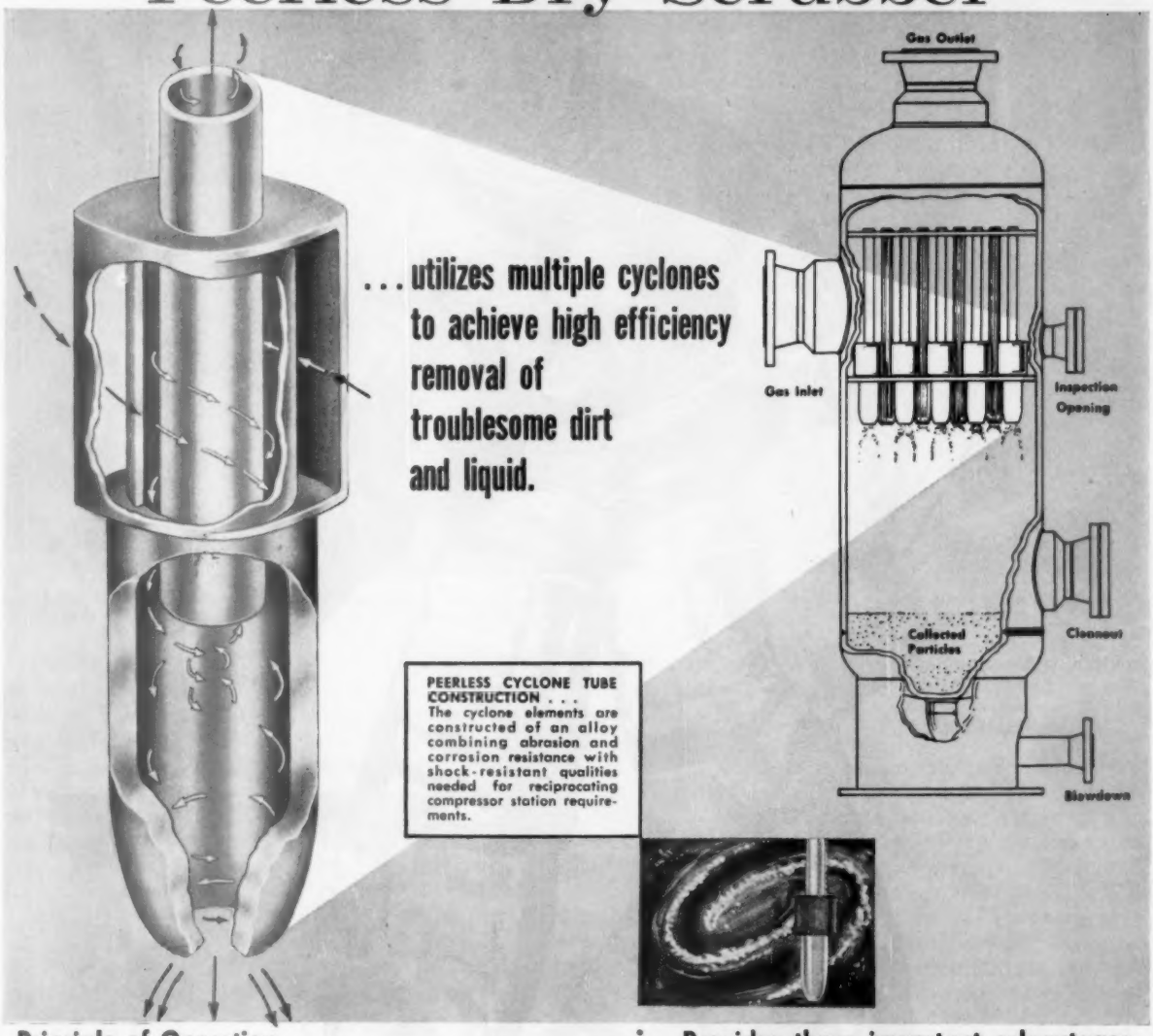
Measurements of pipe temperature in the ditch range between 26° and 52° F.

Welding and testing. Welding practices were the same as used on Midwestern's southern line. The following were 100% X-rayed: river crossings, double-joint welds, and all compressor-station high-pressure gas piping. A minimum of 30% of all field welding was X-rayed.

River crossings were tested hydrostatically and the entire length was gas tested at 970 psig., 110% of operating pressure. Operating pressure is 880 psig.

Another in a complete line of Peerless Scrubbers

Peerless Dry Scrubber



. . . utilizes multiple cyclones to achieve high efficiency removal of troublesome dirt and liquid.

PEERLESS CYCLONE TUBE CONSTRUCTION . . . The cyclone elements are constructed of an alloy combining abrasion and corrosion resistance with shock-resistant qualities needed for reciprocating compressor station requirements.

Principle of Operation

The Peerless Dry Scrubber consists of small diameter cyclones in parallel to provide the centrifugal force necessary for efficient small particle removal at high pressures. Peerless Dry Scrubbers are offered in a complete range of sizes and working pressures to fit any scrubber requirements. Also available are compartmented scrubbers to handle the problems of widely varying flows with only one vessel where multiple scrubbers have been required heretofore. Write for descriptive literature.

Provides these important advantages

1. Efficient removal of dust and liquids.
2. Cannot be overloaded.
3. Uses no scrubbing oil, hence no oil loss.
4. Requires no oil filling or settling tanks.
5. Virtually maintenance free, requiring only occasional blowdown of collected material.
6. Ordinarily smaller and less costly than wet type scrubbers.

Engineering Assistance Available: Peerless makes all types of Scrubbers, including Dry Scrubbers, Oil Bath, both a fixed contactor type (Swirl-Gas Cleaner) and a revolving contactor type (Scrubosphere). In addition, Peerless makes Gas Filters. Ask us for recommendations on the type Scrubber best suited to your application.

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BOLT-ON CONCRETE WEIGHTS are attached to the pipe before it is pushed into the ditch across a peat bog. The ditch was blasted with small charges of dynamite because normal methods with heavy machinery were impossible.

Cathodic protection. Midwestern installed cathodic-protection test leads at road crossings. No shorts were found after construction. Some ground beds were installed where severe ground conditions exist. A corrosion engineer, assigned to the job, checked coatings and soil stress areas, and supervised cathodic-protection installation.

Roads have bored crossings and all public roads are cased. About 20 ft. on each side of cased crossings, sandbags support the pipe which will keep it from contacting the casing.

Contractors

Bechtel Corp. operated two spreads of about 75 and 80 miles each from Canadian border to Becker-Clay county, Minnesota, line. H. C. Price Co. did double jointing for these spreads. Rosson-Richards Co. performed internal coating.

Grayco Constructors, Inc., had one 54-mile spread from Becker-Clay county line to near New York Mills, Minn. H. C. Price Co. had one 56-mile spread from New York Mills to Mississippi River. Houston Contracting Co. had two spreads of about 56 and 53 miles each from Mississippi River to Wanderoos, Wis.

Contracting & Material Co. had one 54-mile spread from Wanderoos to Chippewa River. Panama, Inc., had one 66-mile spread from Chippewa River to Marshfield, Wis., metering station.

Bristow-Hyde Contracting Co. built 39 miles of laterals in Minnesota. Texas Pipeline Construction, Inc., built 16 miles of laterals in Wisconsin.

Houston Contracting Co. built the two compressor stations.

River crossings: Mississippi River—Popich-Marine Construction Co.; St. Croix River—Pentzien, Inc.; and Chippewa River—Missouri Valley Dredging Co.

Main-line pipe was furnished by National Tube Division of U. S. Steel from its mills at McKeesport, Pa., Lorain, Ohio (seamless and heavy-wall), Orange, Tex., and Provo, Utah; Republic Steel Corp., Gadsden, Ala. (60-ft. double joints); and A. O. Smith Corp., Milwaukee. Jones & Laughlin Steel Corp. supplied small-diameter pipe.

First pipe arrived on April 25 and the last on September 1. Pipe was shipped by rail and barge.

Surveying was completed in 36 days. The line was divided into eight segments. Mapping combined the use of photography and ground survey methods.

Initial laying operations started July 11 and major construction was finished September 30.

Pipe Specifications

Total length of pipe for the project is 550.30 miles. The main line is 495.54 miles including dual river crossings at Mississippi, St. Croix, and Chippewa rivers. The pipe is 24-in. diameter, API 5LX-52. Wall thicknesses are: crosscountry—0.281-in. nominal wall; congested areas, highways, railroads, and valve settings—0.344 and 0.406-in. wall; river crossings—0.406-in. wall. The heavier-wall pipes are seamless. Compressor piping was heat treated and tested for 15-lb. impact strength at −50° F.

Laterals totaled 54.76 miles and were: 17.85 miles of 8⅝-in. o.d. by ¼-in. wall, X-42; 20.04 miles of 6⅝-in. o.d. by ¼-in. wall, X-42; 11.07 miles of 4½-in. o.d. by 0.237-in. wall, Grade B; and 5.80 miles of 3½-in. o.d. by 0.216-in. wall, Grade B.

References

1. Reed, Paul, "Midwestern Construction Practices Are Different": The Oil and Gas Journal, Vol. 57, No. 39, pp. 207-209 (Sept. 21, 1959).

2. Parker, Ross O., Jr., and Keller, Ben R. (Cotton), "TGT's Delta-Portland System Uses New Station Design": The Oil and Gas Journal, Vol. 58, No. 11, p. 177 (March 14, 1960).

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1700 tons of ALLIED Pipeline Enamel and 5200 gallons of ALLIED Pipeline Primer were used by the contractors for the Mustang Line, Montin-Harbert Construction Company.

For more information about ALLIED Pipeline Enamels, write to the Pipeline Materials Division of Allied Materials Corp., at the address below.

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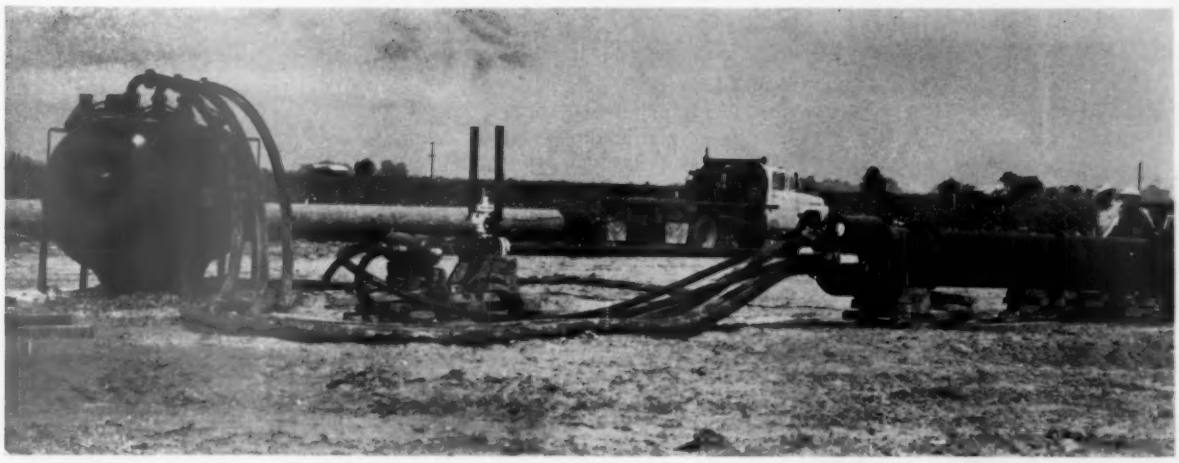

Input Series of tests by Trunkline Gas Co. shows that sandblasting

Discharge is superior to pigging or in-place coating as a means of

Boosting pipeline flow efficiency

BY ADRIAN W. McANNENY
Manager of Engineering Planning
AND LESTER C. SULLIVAN
Supervising Engineer for Research and Development
Trunkline Gas Co.

PIPELINE EFFICIENCY can be increased very significantly by sandblasting. This is the conclusion of a series of tests conducted by Trunkline Gas Co.

These tests showed that:

- Sandblasting gives a cleaner and more efficient pipe than either pigging or in-place coating.
- Efficiencies of sandblasted pipe approach to within 3% of the theoretical maximum.

These tests were part of a program undertaken by Trunkline to evaluate various internal cleaning and coating methods. The purpose was to determine the most economical way to increase flow efficiency.

"E" factor varies. Flow tests performed over a period of several years indicated that different sections of pipeline had "E" factors in the Panhandle A formula which range from 86 to 95% for the same flow rate. The "E" factor for any given section did not vary with time.

This variation between sections was random in distribution and could not be attributed to any single factor or group of factors. It is obvious that the condition of the internal wall surface is a factor and anything that can be done to remove foreign material, dirt, rust, etc. should increase the flow efficiency.

Sandblasting in place by use of compressed air had been used for several years by Klean Kote Co., of La Porte, Tex., for the removal of paraffin, b.s. and w., rust, scale deposits, etc. from pipe of 2 to 8-in. diameter. It had also been used on small-diameter pipe for surface preparation prior to internal in-place coating. If this method were applicable to large-diameter pipe, it would appear that it should effect an increase in pipeline efficiency.

Test methods. Sandblast tests

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were initiated on a ½ mile length of 4-in. pipe to determine the parameters which would permit an intelligent prediction of the applicability of this cleaning method to large-diameter pipelines. Natural gas was used to blow the sand instead of air.

As a result of sandblasting this line, the internal surface roughness was reduced to about 45% of its initial value. The "E" factor, based on the Panhandle A formula, was increased from 82 to 94% or an increase of about 15%. These tests indicated that it should be possible to increase the "E" factor on a 26-in. line at its usual design flow rate to about 102%.

Measurements made before and after sandblasting on a 90° elbow, placed near the outlet end of the test section, indicated that there would be no serious pipe-erosion problem with the field bends. Such problems are normally encountered in pipeline work using this method of cleaning.

Bases sound. Test results on the 4-in. line and the extrapolation of data to a 26-in. line indicated that the latter could be satisfactorily sandblasted. They also indicated that improvements in "E" factor of up to 15% could be reasonably anticipated, depending upon the initial condition of the line. Six sections of pipe with very low, average, and high initial "E" factors were selected for testing. The first section was about 8 miles long with an initial "E" factor of 85%.

The first cleaning test consisted of running a series of three pigs and then running flow tests to determine the improvement in flow efficiency. This sequence was followed until a total of 18 pigs had been run. The last three pigs produced no significant change in the "E" factors. The final value was 96.5% or an overall improvement of about 11%.

The pipeline was then sandblasted and flow tests were repeated. The "E" factor increased to about 101.5%, an improvement of about 5% over that attained by pigging. This "E" factor is only 3% lower than the theoretical maximum obtainable as predicted by the "smooth pipe flow" equation.

Coating tested. The third step was to internally coat this cleaned

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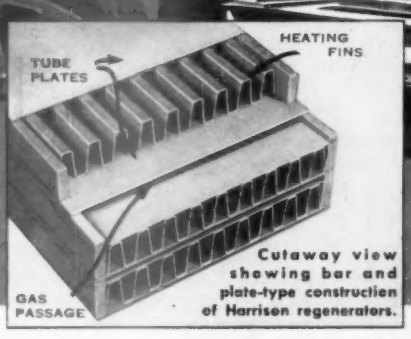

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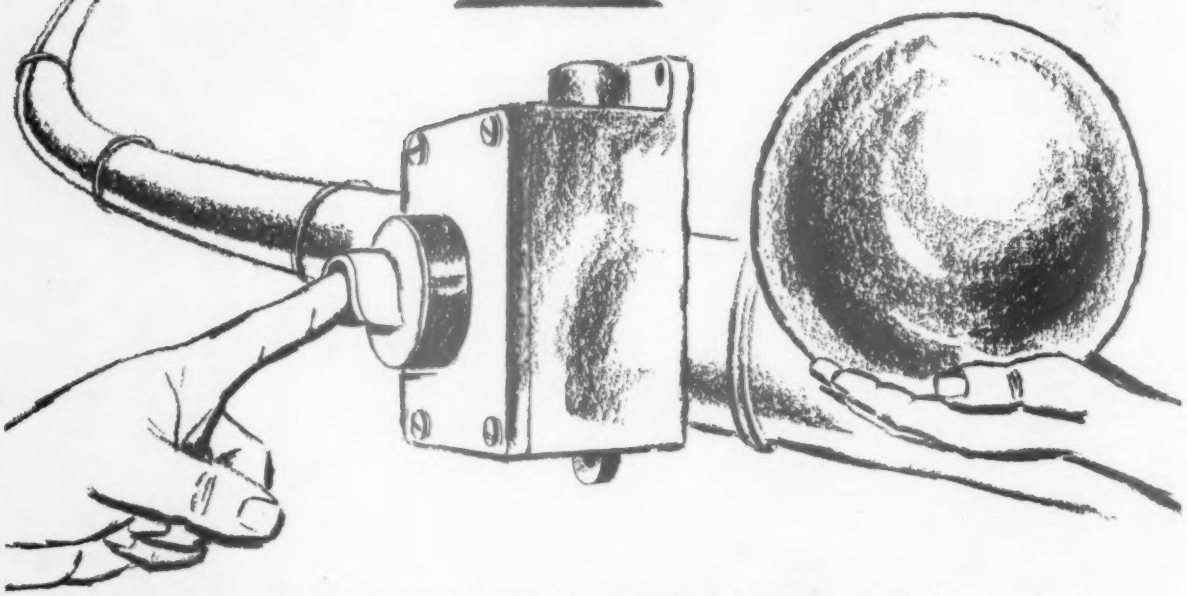

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section of pipe in place and observe the change in flow efficiency.

An attempt was made to do this with an epoxy-type paint. The paint was applied by squeegees propelled by low gas pressure. The paint had all been applied by the time the squeegees were less than halfway through the pipe section, giving a very thick, unsatisfactory film.

Examination of the coating at various points revealed runs, solvent washing, and blistering as well as a ribbon of paint along the bottom of the pipe. This coating, obviously not satisfactory, gave a net reduction in "E" factor for the over-all section of 5%, and a reduction of 13% for that section to which paint was applied.

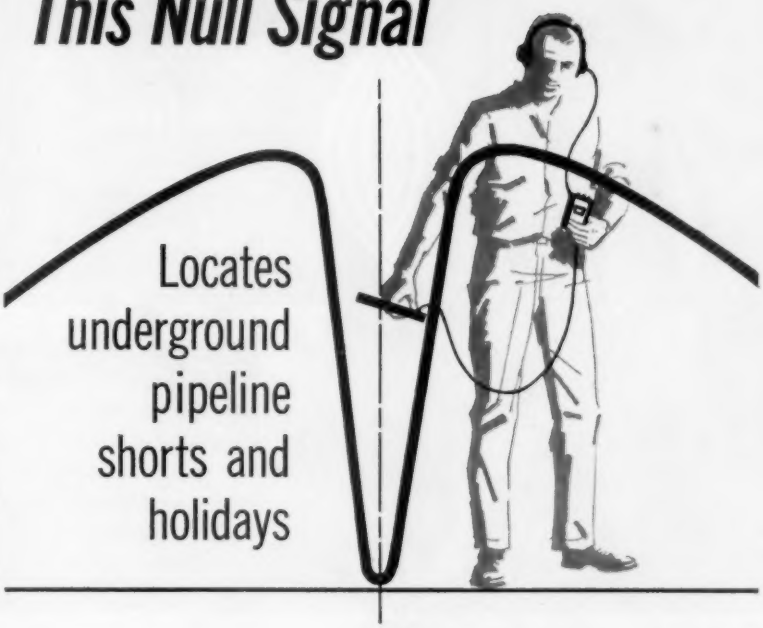
The second section of 26-in. pipe selected for sandblasting was 9 miles long with an initial "E" factor of 86%. Sand was blown through the line in increments of 5,000 lb. until a total of 20,000 lb. had been used. After each blast, flow tests, surface roughness, and pipe-wall thickness measurements were made.

Blast effective. Most of the improvements in flow efficiency and reduction in surface roughness were obtained with the initial blast. The final "E" factor obtained was about 101%, or an increase of about 15% in flow efficiency. The average pipe-wall roughness was reduced to approximately 50% of its initial value. The wall-thickness measurements were made along the back side of a field bend of 1½° per pipe diameter. The erosion rate of the pipe wall varied directly as the number of pounds of sand used. It was constant at about 1 mil per 15,000 lb. of sand at the point of maximum wear.

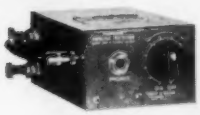
Failure to properly internally coat the first section of 26-in. pipe was attributed primarily to the fact that the paint was too viscous. It was decided to make another attempt to internally coat a line in place. A 1-mile pilot section of the cleaned pipe was selected. The paint was of different manufacture from the first. Based on laboratory tests, the paint was thinned to give the desired viscosity.

The paint was placed between two inflated rubber balls instead of squeegees. One squeegee was placed behind the rubber balls to wipe off excess paint. Visual inspection of

This Null Signal



Locates underground pipeline shorts and holidays



The null search system, teamed with Tinker and Rasor all-transistorized, Pearson-type Detectors, has greatly simplified the location of electrical shorts and holidays in underground pipe coatings. Findings are made within inches because the null is a positive factor which is either present or not present.

The Tinker and Rasor Underground Detector employs a transistorized oscillator which generates a 15 watt, 750 cycle, stable A.C. audio-frequency signal. Two 750 cycle resonate filters in the receiver reject unwanted signals. Using a low impedance search coil, one man can inspect a buried line at a rapid walk. Shorts will be indicated sharply and surely. A two man team is equally effective in locating holidays.

Tinker and Rasor has prepared a complete data kit which describes the null search system as well as other recommended procedures for inspecting protective coatings. Material includes technical data on equipment, general discussion of types of detectors, theory of operation, etc.

Engineering Note:
To insure a perfect application, include Tinker & Rasor Holiday Inspection. Write for specification guide.

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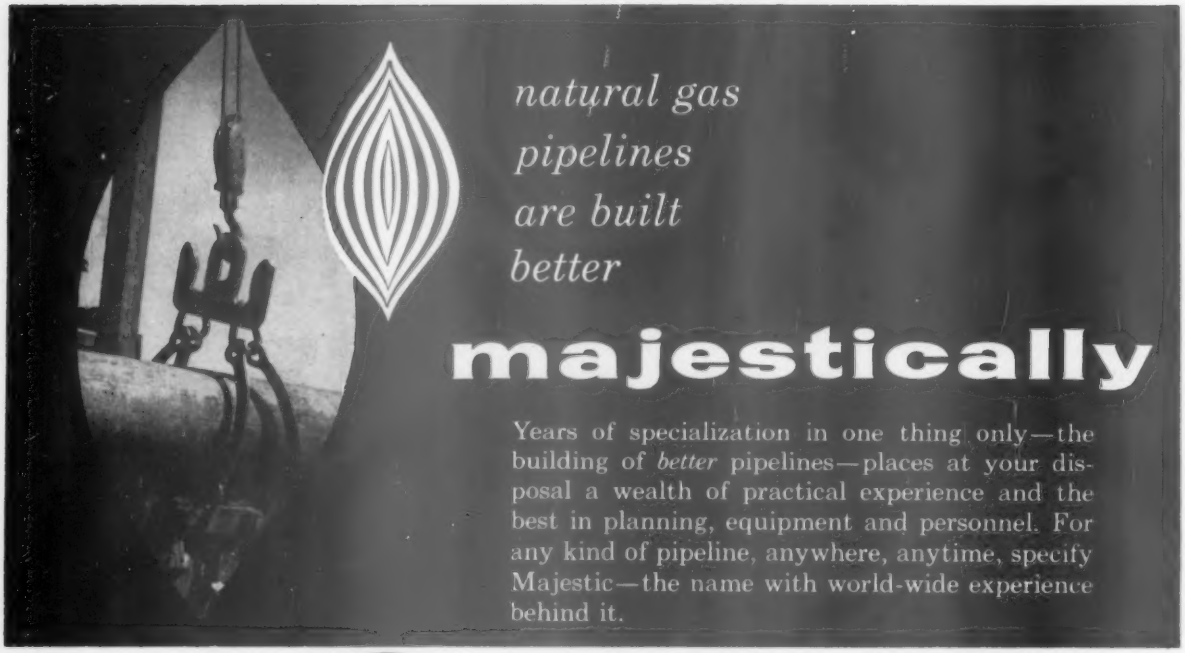

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this section indicated that a very good paint job was obtained.

Six elements. In view of this success, it was decided to paint the rest of the gate setting in a similar manner. Again paint was thinned, and confined between two inflated rubber balls. It was propelled through the line with low gas pressure. A series of three squeegees and one ball were sent through at predetermined intervals immediately after the main paint column, to wipe the wall and extrude a thin coat. They formed a train of six elements.

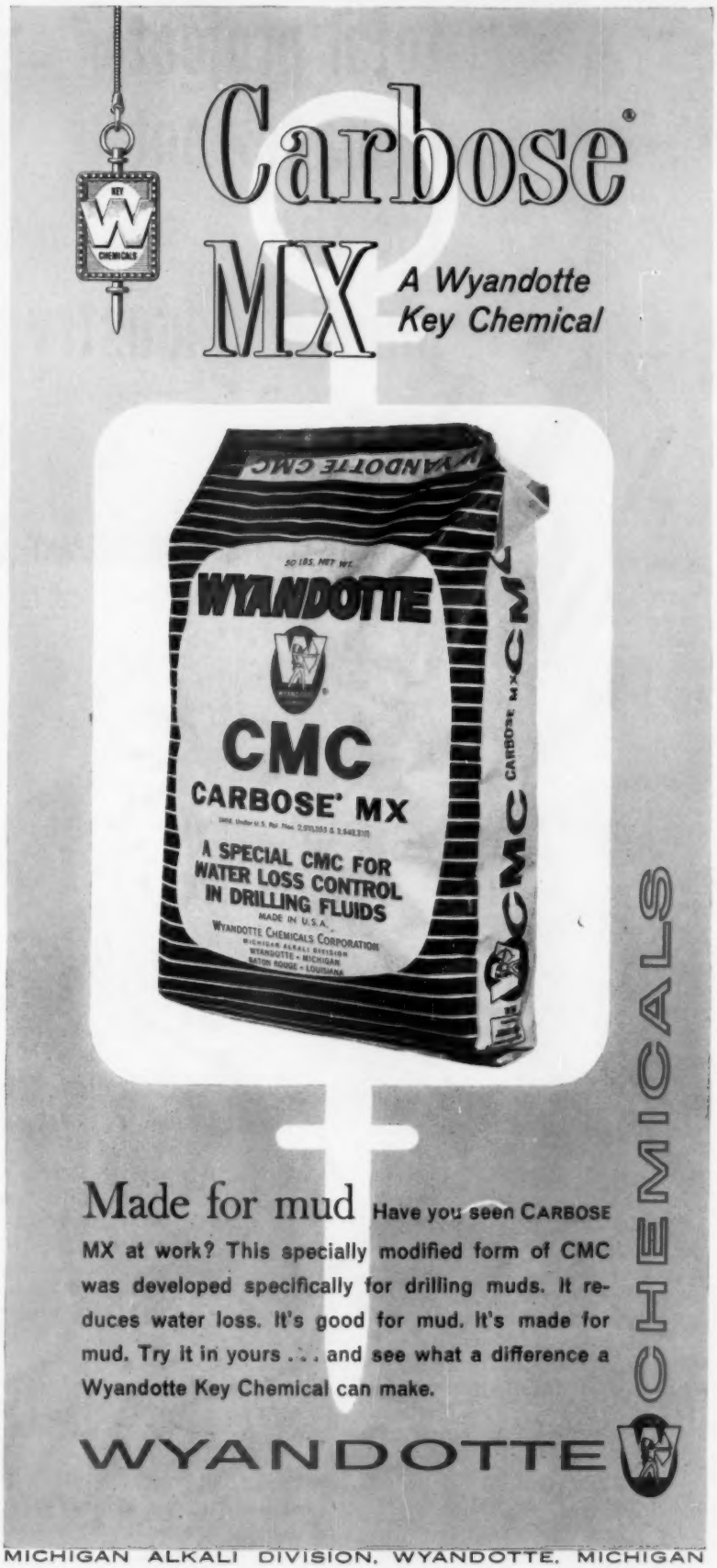
Since the amount of paint left in the pipe is a function of speed, successful application depends on precise speed control. Although the average speed can be controlled closely by the rate of gas admission behind the train, the speed at any given time depends upon the friction between the applying elements and the pipe walls.

When an element hits a restriction, a higher differential pressure must be built up to break it through the restriction. The element then will travel at a high rate of speed, leaving excessive amounts of paint, until it has expanded the pack of gas built up behind it and returns to normal speed. As the train moves farther down the line the column behind becomes larger. This causes the speed control to be even more erratic the farther it travels.

This painting proceded nicely until a heavy-wall section of pipe was reached. At this point it was necessary to increase the pressure until the section was cleared. As soon as the balls cleared this section, their velocity was greatly increased, resulting in a dumping of paint. The result was that a total of 8 miles of pipe received a good coating and the other 1.1 mile received none.

Coating tested. Inspection revealed a reasonably good coating at all locations except portions of the pipe immediately downstream of the heavy-wall section. This section had a large excess of paint. With the exception of this location, a fairly smooth coat was obtained. Measurements made on a test pup cut from the line indicated the following paint coverage: 2 mils at top, 3 mils at sides, and 6 mils on the bottom.

The application of paint reduced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the "E" factor for the portion coated 8% to an "E" factor of about 93%. The "E" factor for the entire section was reduced to 94% or a net reduction of about 7%. This compares with an "E" factor of about 98.5% obtained by Tennessee Gas Transmission Co. on its in-place coating at Refugio.

The third section of 26-in. pipe chosen was 10 miles long with an initial "E" factor of 94%, the highest encountered on this system. While setting up for tests it was noted that the pipe surface was extremely oily. The initial surface roughness measurements on this section were only 50% of those encountered on the other sections, which probably accounts for the high "E" factor.

The effluent sand from this section was oily and oil was still visible on the pipe surface after 25,000 lb. of sand had been used. An additional 20,000 lb. was used, and the last half of this sand came out clean. The final "E" factor on this test was 101%.

Method proved. This test indicated that most 26-in. pipe can be brought to a smoothness by sandblasting to give an "E" factor of about 101% almost regardless of its initial condition. At this point it was decided to forego tests on the two sections with an average "E" factor and the other section with a high "E" factor.

Approximately 460 miles of 30-in. pipe had been placed in service last winter. The fourth section chosen to be sandblasted was an 11.2-mile section of this 30-in. with an initial "E" factor of 91%. This section had the lowest "E" factor of all the 30-in. It was also in an extremely hilly terrain which may have been a contributing factor. This pipe had been stored for 4 months prior to installation and considerable rust had accumulated on the interior. The "E" factor was increased to 101% which is a net gain of 11% due to the sandblasting technique that was employed in the tests.

These tests were run jointly by Trunkline Gas Co. and Sharman, Allen, Gay & Taylor, Inc. The sandblasting equipment used for these tests was designed, supplied, and operated by J. D. McCune, of Klean Kote Co.

Tests show that grinding for stringer-bead preparation insures Fig. 1.

BETTER PIPELINE WELDING

Gross cost of welding is reduced, including cost of weld repair. It's found that high heat cutting is not required in running the hot pass, so it can be run faster

BY A. G. BARKOW, Superintendent of Inspection Dept., Natural Gas Pipeline Co. of America, Chicago.

THE ROOT BEAD as well as all other beads must be cleaned before the next bead is applied. This is clearly stated in all welding specifications. And it is also indisputable that the root bead and the so called "hot pass" or second bead are the most critical beads of the weld.

Furthermore, the root bead because of its natural geometry is the most difficult to clean because of the unavoidably irregular surface of the bead and the tendency of the electrode to undercut the side walls. Since the welder must depend on the bridging of the weld metal to join the two sidewalls—with no base to weld against—changes in spacing and changes in lip thickness present constant problems in arc manipulation.

It therefore is not too uncommon that burn-through holes or "windows" are left in the root to be filled, deep pinholes occur, or the metal piles up in small nobs. The second-pass welder, using a high heat, attempts to wash out all of these irregularities and leave the desired concave weld geometry so necessary for the final welders.

While the hot-pass welder does a remarkably fine job under these most difficult conditions, it is physically impossible to clean out all of the irregularities. Thus, welds are completed, and, upon radiographic examination, are found to contain defects greater than allowed by the standard.

Quality of welds has been of prime importance ever since welding became the tool for joining high-pressure line pipe for cross-country transmission systems. Because of its importance, the root bead possibly has received more consideration than any other bead. Widening of the included angle of bevel produced beneficial results in reducing the crown to an almost flat surface and also in reducing sidewall undercutting.

However, the wider groove did require more weld-metal deposit which slowed welding progress and left a somewhat thinner weld-metal bridge that was susceptible to cracking when placed under strain. A compromise 37½° bevel or 75° included angle was found to improve the quality of the weld quite considerably and was used successfully on a number of major transmission lines.[1] The fact still remained that the economy of welding was disturbed in both material cost and time.

Experimental studies of welding characteristics of the hot pass and its ability to cut out possible causes of welding defects showed that only a limited number of defects could be so removed. It was impossible

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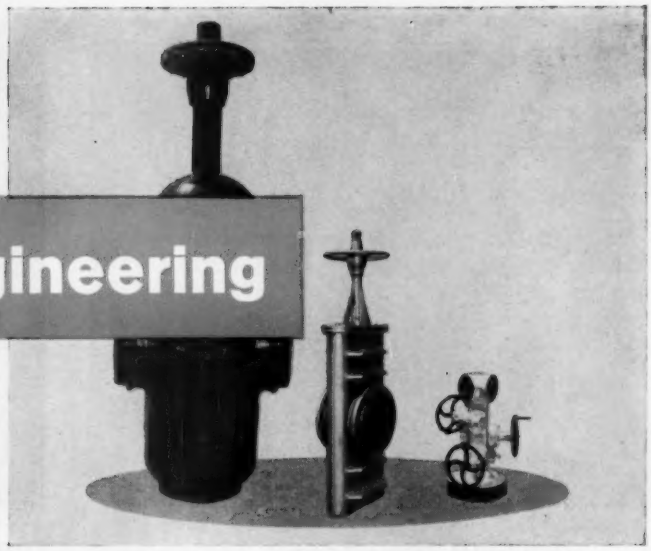

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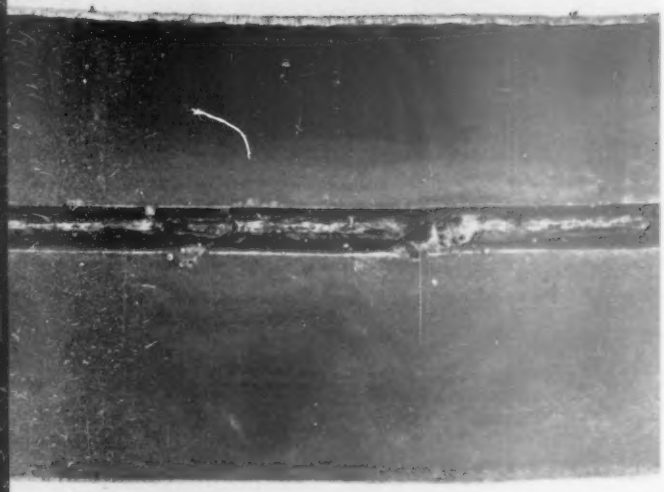
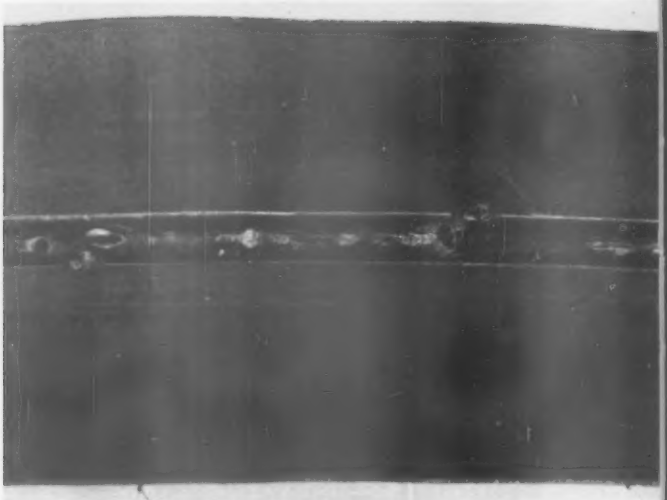
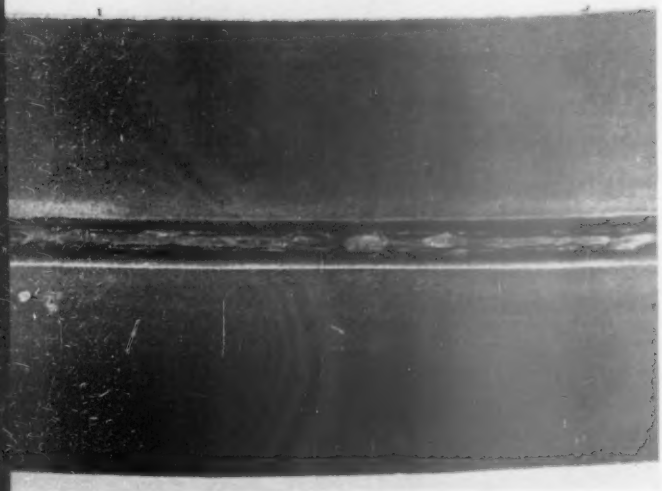


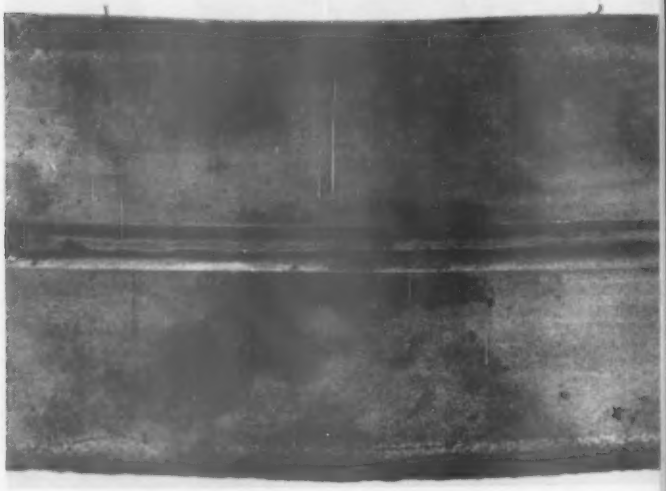
EXPERIMENTAL WELD not cleaned. Fig. 2.



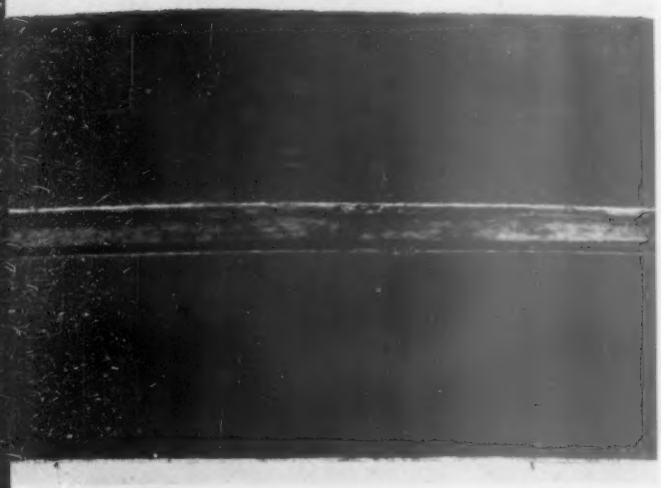
EXPERIMENTAL WELD cleaned with brush and ice pick. Fig. 3.



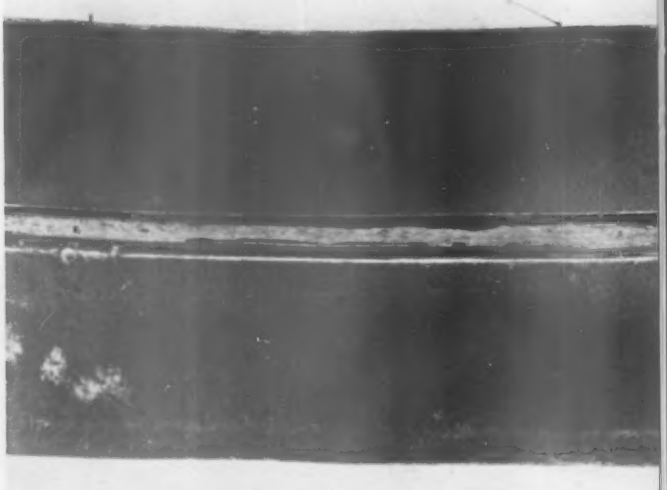
EXPERIMENTAL WELD cleaned and chiseled. Fig. 4.



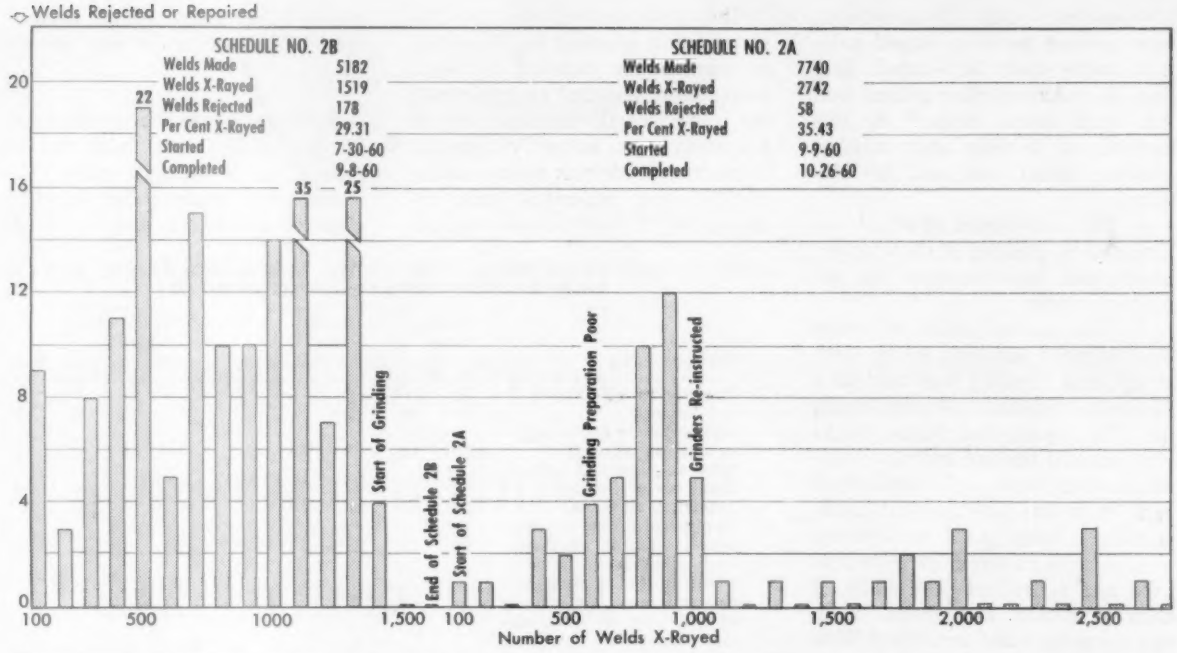
EXPERIMENTAL WELD sand blasted. Fig. 5.



EXPERIMENTAL WELD ground to maximum extent. Fig. 6.



EXPERIMENTAL WELD ground to minimum extent necessary for good welding quality. Fig. 7.



COMPARISON OF WELDS rejected as the schedules progressed shows the effectiveness of grinding for root bead preparation. Fig. 8.

to cut out "windows" that had heavy walls, slag lines buried deep in the side walls and which could not be cleaned by brushes or ice picks, deep narrow holes, and pits.

The characteristic flow of electricity from sidewall to electrode is such that the nearer surfaces will support the entire arc and the deeper surfaces are insulated by distance so that no current flow exists to carry the metal to these depths.

Test program. A development program to change the characteristics of the manual electrode for use in welding the stringer or root bead thus far has not been successful. It therefore was decided to develop a program in mechanical weld preparation to produce what could not be obtained by welding. The program had to accomplish six main objectives:

1. The preparation method had to be suitable for field practice using field hands.

2. The preparation method had to produce a weld surface that was substantially cleaner than now is possible.

3. The preparation method had to produce weld contour which lent itself more readily to second-bead welding.

4. The resulting completed weld would have to be consistently cleaner with a sizable reduction in weld rejections.

5. The method would have to be economical and could not cause a reduction of progress speed.

6. The method would have to meet the general acceptance of the contractor, welder, and inspector.

Before the program was started, past construction details and radiographs were studied and the occurrence of defects tabulated. This tabulation showed that slag, porosity, and burn-through areas caused most rejects. The study also showed that, in the 40% of welds radiographed, 5.6% were rejected because of defects exceeding the limits of the standard.

It was assumed that in the 60% not radiographed, a similar condition existed and that these defective welds were not removed. This fact gave a strong reason for the program. The examination of the radiographs also showed a large number of welds with defects which were within the acceptable limit, but nevertheless were not desirable. The possible reduction of this type of defect was another good reason for the program.

The weld preparation program consisted of three parts:

1. Development of an acceptable method.

2. Acceptance by company welders.

3. Field trials under a scheduled construction program.

First stage. During the first development stage, a series of welds was made using different methods of cleaning. All welds were made by actual field welding practices and under simulated field welding conditions. Seven series of welds were made as follows:

1. The first series of welds was cleaned by presently used methods, using a power-driven wire wheel and ice picks to remove slag as well as possible.

2. The second series of welds was cleaned by the same method as the first series except that great care was used to remove all slag from undercuts and other pockets.

3. The third series of welds was cleaned by the same method as the first series with the additional use of diamond-pointed cold chisels to remove high spots, cavities, and most other irregularities. All beads were so cleaned.

4. The fourth series of welds was cleaned by sandblasting, using a fine silica sand. All beads were so cleaned.

5. The fifth series of welds was prepared by grinding all defects to

a vanishing point. Burn-throughs were ground to have sloped sides that readily could be welded. Slag lines in undercuts were ground out. All beads were cleaned by this method. A 3/16-in. wide alumina grinding wheel was used for this work.

6. The sixth series of welds was prepared by grinding of the first two beads and wire-brushing the remaining welds.

7. The seventh series of welds was prepared similarly to the sixth except that grinding was used to a minimum required for good welding. This means that wagon tracks were opened but not entirely eliminated. High points were rounded off and burn-throughs opened sufficiently to allow good penetration.

A careful record of technique used and a detailed time study of each operation was made. Each move was recorded and timed. Rest periods, rod change time, etc., were recorded separately and were not added to welding or cleaning time. A stop watch was used for this timing. Figs. 2 to 7 show sections of welds cleaned by the various methods used in this program.

All welds were subjected to radiographic examination. The radiographs were made under laboratory conditions using very fine-grain film so that minute details of each weld could be read. Each radiograph was read inch by inch and even the smallest defect was recorded as to size and location.

Radiographic results were tabulated and compared in the final appraisal. No physical or chemical checks were made. However, metallographic specimens were cut from welds cleaned by the grinding methods to check on crack possibilities. No traces of cracks were found during this examination.

All data accumulated during the test program, Stage 1, were carefully studied and appraised. Table 1 gives a typical comparison of results of weld analysis from each series. A comparison was made between weld-cleaning time of each type of weld and the number of defects found. A balance between weld quality and production time was then struck. From this appraisal, method No. 6 was selected as the most favorable method to be used in the next stage of the program.

This portion of the program showed that grinding and brushing, as methods of cleaning for weld preparation, required approximately the same length of time. Defect frequency was greatly reduced. Burn-through defects were reduced 54.5%; slag inclusions were reduced 28.7%, and porosity was reduced 82%. These results encouraged continuation to the second stage.

Second stage. In the second stage, 20 test welds were made by 10 groups of 2 welders each. Ten welds were made using the first cleaning procedure and 10 welds

TABLE 1—FIRST-STAGE TESTS, TIME STUDY, AND RADIOGRAPHIC RESULTS OF SEVEN DIFFERENT CLEANING METHODS

Cleaning method	Welding time (min.)	(sec.)	Cleaning time‡ (min.)	(sec.)	Number of Defects† Slag	Gas	Burn through	Total	% Ratio
1. Power-driven wire wheel and ice pick	29	04	7	11	28	23	11	62	100
2. Same as above (extra care in removing all slag)	31	19	8	59	14	17	10	41	66
3. Same as above with additional use of chisels	32	17	42	38	14	19	9	42	68
4. Sandblast all passes	28	49	16	10	24	15	9	48	77
5. Two power driven grinding wheels. Used on all passes	38	22	22	51	18	10	4	32	52
6. Two power-driven grinding wheels (used on first two passes); ground out contour of first and second passes and removed all slag lines; wire-brush remaining passes*	31	25	7	39	22	4	5	31	50
7. Same as above except only ground enough to open slag lines	29	20	4	56	20	17	11	48	77

*Selected as method most suitable for weld conditioning. †These represent total of all defects, regardless of size of defect. ‡Note that except for the cleaning by method 3 all cleaning times are less than the welding time.

TABLE 2—SECOND-STAGE TESTS' TABULATION OF DEFECTS FOUND BY RADIOGRAPHIC EXAMINATIONS OF THE 20 TEST WELDS

	Standard cleaning: No. of defects	Standard cleaning: Total inches of defect (in 1,758 in. of weld)	Cleaned by grinding: No. of defects	Cleaned by grinding: Total inches of defects (in 1,758 in. of weld)
Slag lines	74	57 5/8	26	12 3/16
Slag inclusions	66	13 3/4	7	1 1/2
Burn-through (Not filled)	7	2 1/16	*0	0
Burn-through (Filled) (Slag)	13	4 1/8	10	3 1/4
Burn-through (Filled) (Clean)	5	.....	22	.....
Totals	165	77 3/16	65	16 5/16
% Reduction			61	79

*Note: Burn-through areas cleaned by grinding were all completely filled. Porosity was reduced by approximately 70% in the welds cleaned by grinding.

TABLE 3—VISUAL EXAMINATION OF CROSS-SECTIONED SPECIMENS OF TEST WELDS 'S' AND 'T'*

Location of defects	Number and Distribution of Defects: Root S	Root T	Hot pass S	Hot pass T	Total S	Total T	% /specimens S	% /specimens T
Type of defects								
No defects					22	52	22.4	51.5
Slag	10	0	22	6	32	6	32.6	6.0
Wagon tracks	0	1	24	1	24	2	24.5	2.0
Lack of fusion	4	1	5	1	9	2	9.2	2.0
Gas pockets	7	4	21	3	28	7	28.6	7.0
Lack of penetration	10	1	2	0	12	1	12.2	1.0
Overlap x/crack	3	3	0	0	3	3	3.1	3.0
Shrinkage void crack	10	2			10	2	10.2	2.0
Under w/crack	0	1			0	1	0.0	1.0
Lack of penetration w/crack	1	0			1	0	1.0	0.0
							Defects/specimens	
Total	45	13	74	11	119	24	1.21	0.24

S = Weld cleaned by conventional means—26-in. o.d. by 0.250-in.—wall 5L × 52—98 specimens.

T = Weld prepared by grinding—26-in. o.d. by 0.250-in.—wall 5L × 52—101 specimens. Both welds made by same team of welders Test nipples cut from same pipe. Field beveled: Same technique and welding conditions.

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D	2" x 60"	2.6	46	Ground Bed
E	3" x 60"	4.0	115	Salt Water
G	2" x 9"	0.4	5	Ducts
J	3" x 36"	2.5	80	Salt Water
M	2" x 60"	2.8	57	Salt Water

*Applicable also in fresh water service. Should not be used in ground beds without backfill.

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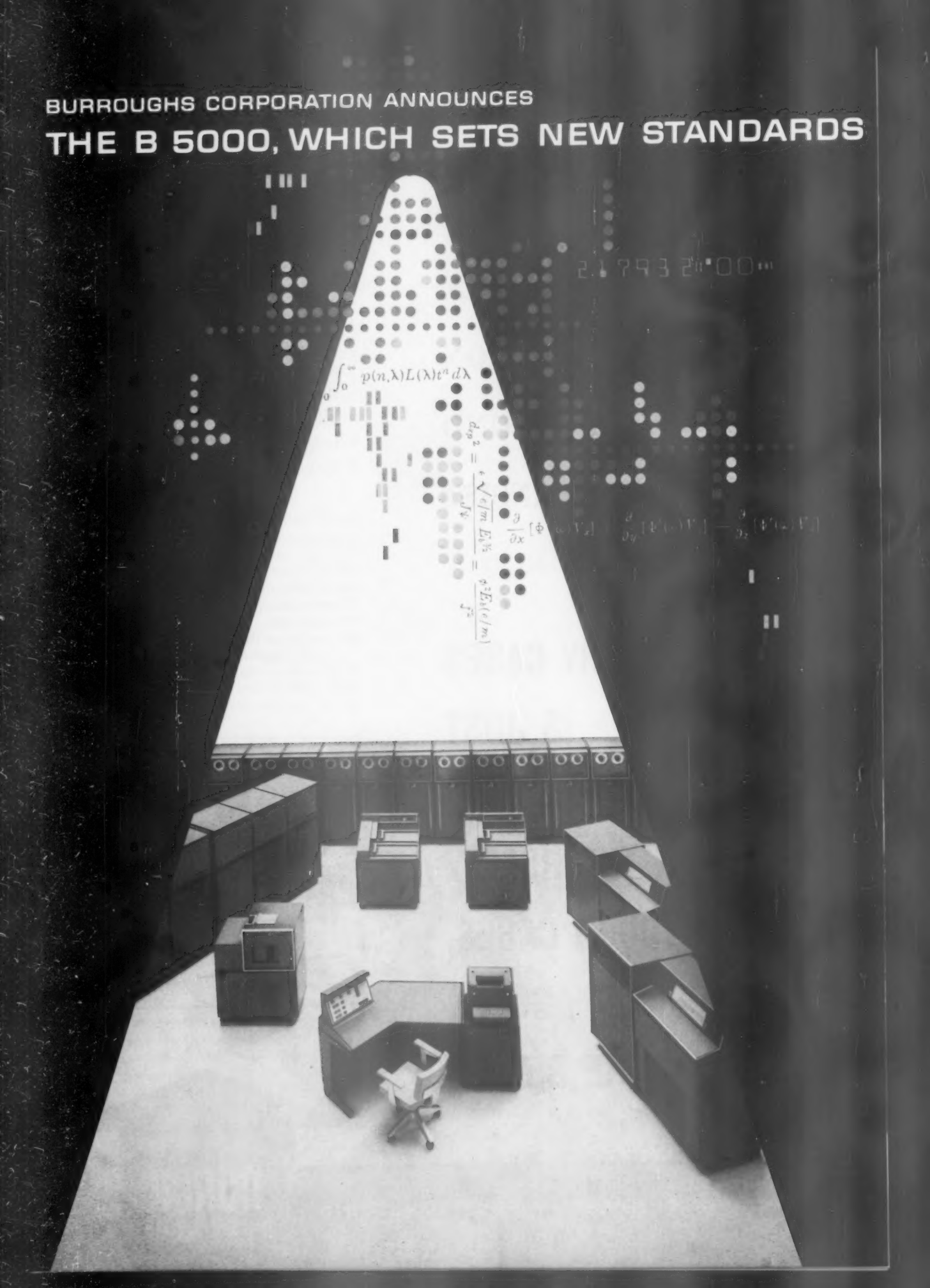
THE B 5000, WHICH SETS NEW STANDARDS



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were made using the sixth procedure. In all cases, the procedure was new to the welders and all used standard field welding technique. No communication was made between any two groups to assure that in each case this was the first weld prepared by this method. The same engineer collected data of these tests so that the analysis of welds in the first and the second stage would be similar.

All welds were subjected to radiographic examination and each film was minutely examined and defects tabulated.

Table 2 is a tabulation of total defects found in all welds and compares the results of the 10 welds by each of the two methods.

Table 3 is a tabulation of the results of this examination. This examination again shows the substantial improvement in defect elimination.

Third stage. The third stage of this program was the actual use of the weld preparation method of cleaning on an actual pipeline-construction program. For this purpose, a 28-mile, 12¾-in. gas line was chosen. The line was laid in Love County, Oklahoma, by R. H. Fulton Construction Co. with Bill Cohoon as superintendent, H. L. Wright as chief inspector, and Fred Clark as welding inspector.

To make this test application as informative and unbiased as possible, the first and last 7 miles of the line were cleaned by the presently used wire-brush method and the center 14 miles by the new grinding method.

It was anticipated that both the first and second beads would require weld preparation by grinding. However, it was reported that after a well-prepared stringer bead, the second bead produced a desirable concaved surface. No undercutting occurred and grinding of this bead could be omitted. Therefore, only the stringer bead was prepared by this method and all following beads were cleaned by presently used brush method.

Radiographic inspection was used in this construction program, with 24.8% of the total of 3,120 welds being so examined. All film was reviewed and analyzed by statistical sampling. The analysis showed that in the case of welds prepared by wire brushing, discontinuities of an acceptable nature were found in approximately 4.9% of the linear inches of weld. In welds prepared by the grinding method, similar but generally smaller discontinuities were found in approximately 0.68% of the linear inches of weld.

For the normal brushing method, the 8-day period was in the last quarter of the line. To analyze both methods at times when the highest production was achieved, 2 days for each type of cleaning method were chosen. Here again 100 radiographs were selected and analytically examined. The results of this examination compared favorably with previous test results.

Results. A program to improve the quality of pipeline welds by use of a better cleaning method has analyzed the several methods available and has developed a new method of weld preparation using a 3/16-in. grinding wheel for cleaning and contour grinding of the first or root pass. The improved contour allows the use of normal wire-wheel cleaning for all other passes.

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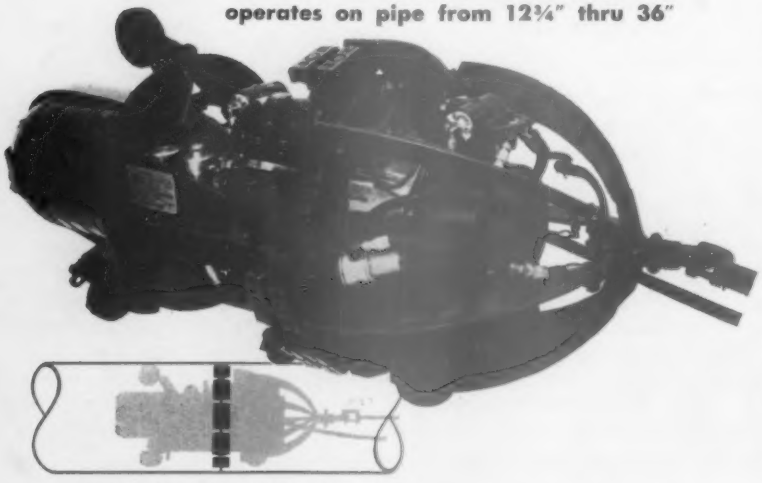

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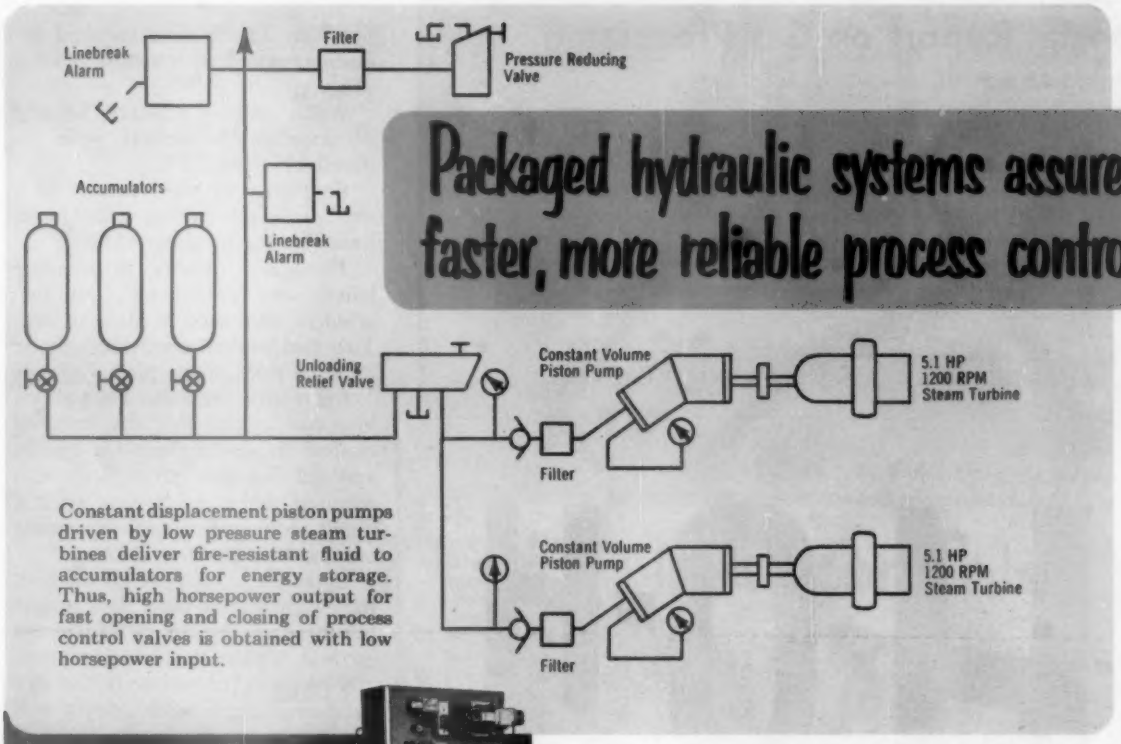

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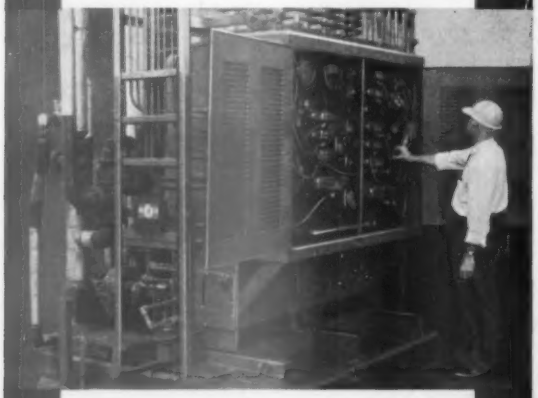

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The grinding of the root pass does not increase the time required for cleaning nor does it retard welding progress.

Welds entirely rejected because of unacceptable defects were reduced by about 75%.

Frequency of weld defects of a size acceptable within code limits were reduced by about 85%.

The same number of cleaning hands were required; but two grinders were used in place of one. Two men worked simultaneously on opposite sides of the pipe.

Contractor, welders, and welding inspector agreed that the grinding method improved the weld quality and did not slow progress. It was reported that the hot-pass welders didn't require the high-heat cutting arc and they could weld faster.

In the use of the grinding method, the cleaning crew must do a proper job to obtain the full benefit of the method. Unless the grinding properly prepares the surface of the root bead, the clean welds sought will not be produced. However, grinding is more definite and a poor job readily can be detected.

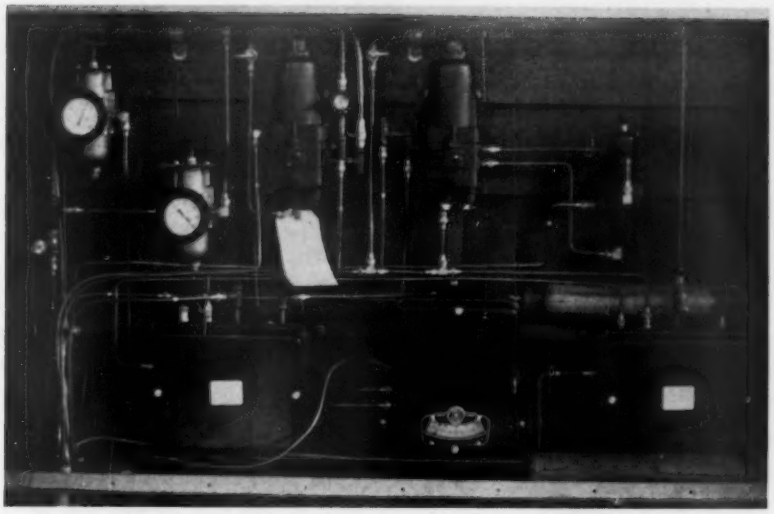
Welds improved. This method now has been used on several large-diameter construction programs, including 24, 30, and 36-in. pipe. Contractors who have used the method agree that it improves the quality of their welds and that this reduction in defective welds will reduce the gross cost of welding which includes a weld-repair load factor. The amount of load-factor reduction is now being studied. Fig. 8 graphically illustrates the effect of grinding on weld quality and also shows the reverse effect if grinding is not thorough.

One major objection raised by contractors is the cost of presently available grinding wheels in terms of welds so prepared. Development of grinding wheels especially designed for this work is presently in progress. New-type grinding wheels which should be more efficient and which will substantially reduce the per weld cost of the grinding wheel now are being tested.

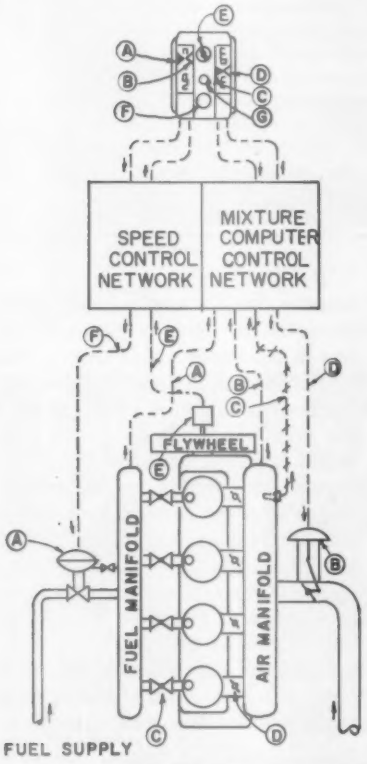
References

1. "30° Bevel Best for Pipelines" by L. J. Cunningham and S. V. Williams: The Oil and Gas Journal, May 30, 1955, p. 70. "The Case for the 37½° Bevel" by R. G. Strong: The Oil and Gas Journal, September 19, 1955, p. 123.

INTERNAL VIEW of the mixture and speed-control system package, with cover removed. Fig. 2.



SCHEMATIC diagram of the engine and control system, showing hardware requirements. Fig. 1.



SUPERVISORY PANEL
- A. Speed set-point gage
- B. Tachometer gage
- C. Mixture set-point gage
- D. Mixture gage
- E. Auto-hand mixture switch
- F. Speed setting knob
- G. Mixture setting knob

CONTROL SIGNAL
- A. Fuel pressure
- B. Air pressure
- C. Air temperature
- D. Mixture control output
- E. Speed pressure
- F. Speed control output

ENGINE HARDWARE
- A. Fuel control valve
- B. Air control valve
- C. Fuel balance valves
- D. Air balance valves
- E. Tachometer

AIR DELIVERY after cleaning, compressing, cooling, or other treatment.

New controls step up efficiency of compressor engines

Automatic device regulates speed and mixture. Improved fuel economy makes for early payout

BY J. M. RANCK

A NEW automatic mixture and speed-control system has proved to be highly successful on a turbocharged four-cycle 1,800-hp. gas engine driving a pipeline compressor. Savings in fuel make it a self-paying system, with the average installation expected to return the initial investment in 1 to 2 years.

If a compressor is operated at reduced loads and low intake air temperatures, there is greater need for such a control system. Even greater savings in fuel will accrue.

The new system is now being studied for application on recent model two and four-cycle engines of larger size. There seems to be no reason why similar savings cannot be effected.

Combustion Mixture

The combustion mixture in an engine power cylinder is the result of combining a charge of air and a charge of fuel from the engine manifolds. In a well-maintained engine, the fuel and air manifold pressures and temperatures will determine the combustion mixture in the power cylinder. Under a given torque and speed imposed by the engine load, reproduction of a given mixture will reproduce a given indicator diagram. Any change in the mixture will alter the shape of the indicator diagram, but the area will remain the same.

The shape change of the indicator diagram is most noticeable in the change in peak pressure which, when properly used, becomes a useful measure of the effective combustion mixture in a power cylinder. (A duplicate peak pressure may be obtained with air deficiency, but normal engine operation does not take place under such conditions.)

The author

J. M. RANCK

. . . supervisor of Research Testing in Panhandle Eastern Pipe Line Co.'s engineering and research division, has devoted most of his career to pipeline design, engineering, and research and to compressor-station construction and operation. He has been with Panhandle Eastern, with the exception of 1 year, since receiving his BS in mechanical engineering from Kansas State.

Emphasis on costs and economy points up significance of these new controls

PRESENT DAY emphasis on pipeline operating economy and the increased cost of fuel have brought about a need for optimum economy in engine performance. Higher b.m.e.p. engines and increased application of turbocharging make it possible to obtain improved economies but many such engines do not maintain optimum performance.

The average engine, today, is operated on an occasional tuneup. This tuneup may or may not obtain optimum performance at the time and under whatever conditions exist for the tuneup. Between these occasional tuneups, the engine seeks its own way to whatever performance may result from the normal, fixed, mechanical settings obtained at the time of tuneup.

Variations in speed, b.m.e.p., ambient temperature, humidity, and barometer, not to mention the mechanical settings of ignition, valves, and other engine hardware, may produce sizable effects on the engine's performance. Sensitivity to these variations increases with engine compression ratio and the application of turbocharging.

Such variation effects on the engine's performance may reach a point where damage to the engine may occur due to alterations in the combustion mixture. The application of a reliable automatic control system to maintain optimum engine performance under varying operating conditions is needed.

Proper use of peak pressure as a measure implies that small cyclic variations must be cared for by averaging the peak pressures of each cylinder for a finite number of cycles before determining the average of all power cylinders. Statistically, at least eight cycles per cylinder are required to achieve satisfactory results, as determined on development tests using metered fuel and air for correlation purposes.

Mixture change. In the normal engine operation, wear and deposits cause the effective mixture to change. Routine adjustments and cleaning can return the engine to normal. Adjustment is often necessary to compensate for deposits in the air, fuel and exhaust systems. Balancing of each cylinder peak pressure by adjusting the fuel charge will compensate the fuel system and a similar technique applied to the air charge will compensate the air system.

The proper combination of both techniques will produce even greater results in maintaining the distribution of mixture to all cylinders. Automatic control of the manifold supply conditions to the air and fuel systems of all cylinders of an engine will maintain the distribution of mixtures over the range of engine operation.

If the automatic control system can obtain a predetermined peak pressure at any operating condition within the engine's range, the desired mixture control will be achieved. A study of the engine's range must be made to find the desired mixtures and their associated peak pressures to complete the control application.

Intake air. The range of intake air conditions with which the engine must operate are those imposed by nature. Annual dry-bulb temperature variations commonly reach 100° F., which represents a 20% variation in the density of the air charge. Barometer variations commonly reach 4 in. Hg, which represents a 15% variation in air charge density. Annual humidity variations commonly reach 300 grains per pound of dry air, which represents a 4% variation in air charge density.

The barometer effect is self-compensated in the use of controls which sense all pressures of fuel and air relative to the barometer. The humidity effect on air density is negligible since a large portion of this 4% effect is a seasonal change. The humidity also acts as a combustion retarder but, normally, this effect is minimized since the moisture enters in the vapor phase without the availability of evaporative cooling.

The frequency of occurrence of the combustion cycles varies with engine speed and the accompanying change in ignition and admission timing alter the combustion mixture and the peak pressure produced by a mixture. Control of both mixture and ignition timing may appear to be necessary. However, a satisfactory control is obtained using mixture control only. For engine-starting conditions, ignition timing may require control on some engines.

Control System

Control of the combustion mixture, as explained in the foregoing, becomes essentially a control of peak pressure. Peak pressure and inertia are the key factors in determining engine stresses which, in turn, become the limiting factor in load-carrying ability of an engine. For optimum mixture control, using fuel economy as one criterion, a fixed relation between peak pressure and b.m.e.p. may be obtained for any engine.

Thus, for a given b.m.e.p., a definite peak pressure which corresponds to the desired optimum mix-

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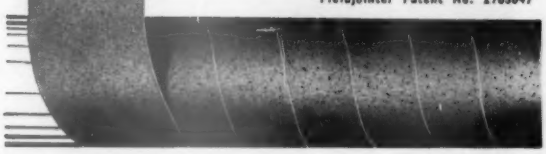

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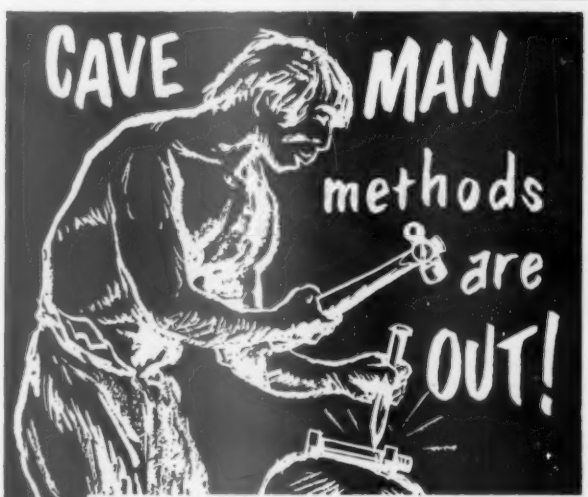

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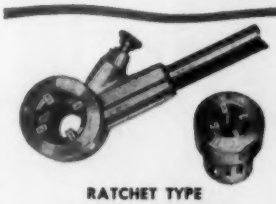

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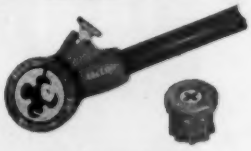

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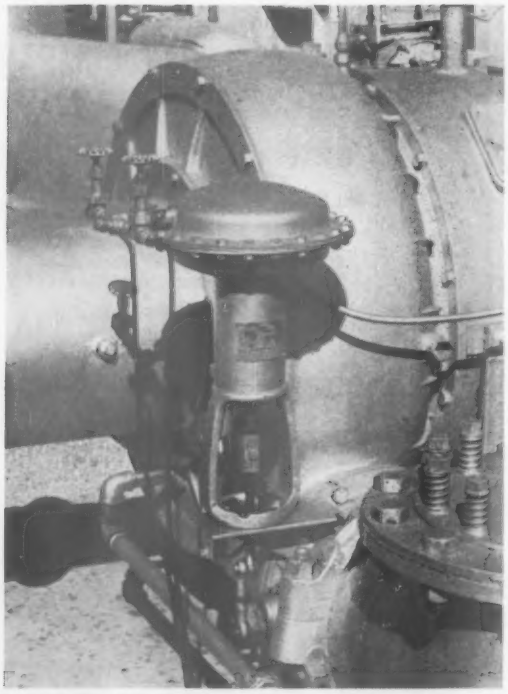
SUPERVISORY CONTROL panel remote mounted at the engine starting panel, showing the simplicity of operating controls for the system. Fig. 3.



AIR-CONTROL valve located in the turboblower discharge line ahead of the backfire relief cover. Fig. 4.

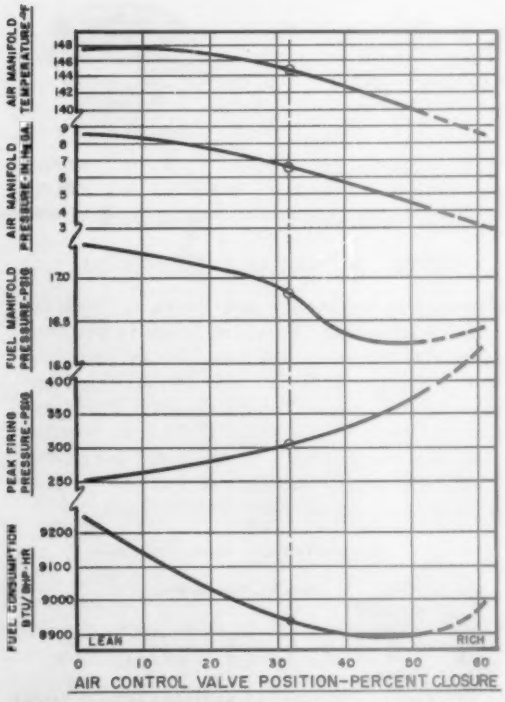
ture will be sought. The desired optimum mixture can be chosen by any consistent criteria of operation.

Control of combustion mixture must embody measurements of the following variables to satisfy the foregoing conditions of performance:

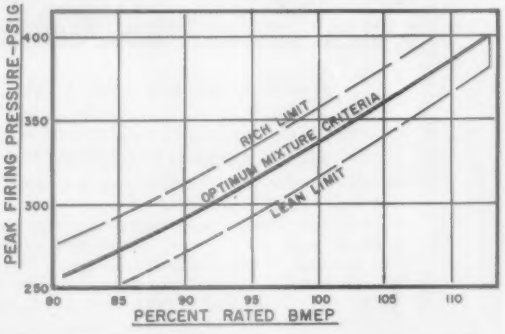
1. Fuel manifold pressure.
2. Air manifold pressure.
3. Air manifold temperature.
4. Engine speed.

(Fuel manifold temperature may be added if fuel-supply conditions are variable.)

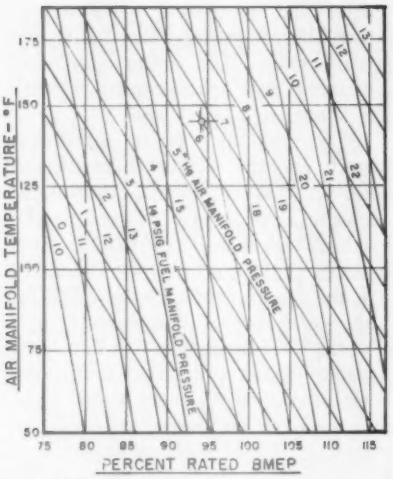
The problem now becomes one of finding the proper relationship between the variables which will function as a control index. An examination of the engine operating conditions over the intended operating range should produce data required to establish such an index. It should be kept in mind that if the engine will operate satisfactorily on manual control of mixtures, it



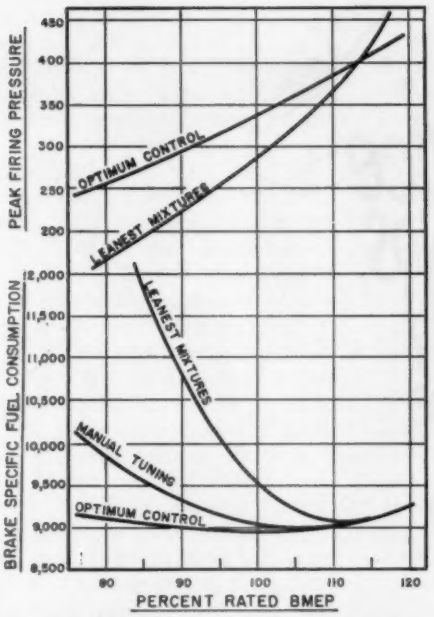
A TYPICAL ENGINE-MIXTURE spectrum measured at 93% rated b.m.e.p., rated speed, and 40° F. air intake temperature. Fig. 5.



PEAK PRESSURE versus b.m.e.p. curve for the criteria of operation of the text, showing upper and lower tolerance levels. Fig. 6.



GRAPHIC FORM of the computed control index equation, representing the locus of all optimum mixture values. Fig. 7.



FUEL CONSUMPTION and peak pressure versus b.m.e.p. for the development engine, showing the relative peak pressures and fuel savings obtained under automatic mixture control for 40° F. intake-air temperature. Fig. 8.

will also operate satisfactorily on automatic control of mixtures, and vice versa.

Two-way operation. A set of engine hardware must be provided which will serve the automatic control system, and which may be manually operated to examine the available mixtures to the engine over the intended operating range. This equipment is illustrated in Fig. 1.

The air and fuel systems employ similar design in that a control valve is provided before the supply manifold and balancing valves are provided at each cylinder after the manifold. The speed-control network will operate the fuel-control valve independently, and the mixture-control network will dependently operate the air-control valve.

To assure stable speed control of the development engine (turbocharged, four-cycle, 24-by-36, horizontal, rated 1,800 b.hp. at 125 r.p.m.) a speed-control network was developed in conjunction with the mixture control network. This speed-control network is a simple differential-sensing proportional control with reset. The proportional and reset time constants may be independently adjusted to separately eliminate governor "hunt" and "wander." The loop feedback design has no "speed droop" beyond that incurred by the small viscosity changes in the hydraulic fluid.

Speed-control. Speed set point is made at the remote supervisory panel where the engine speed is displayed adjacent to its set point. It is necessary to have a stable speed control with satisfactory regulation as part of the basic engine hardware before applying mixture control since errors in the speed control carry over to the mixture control.

Nomenclature

- P_a = air manifold pressure, in. Hg ga.
- P_b = mixture index = computer balance pressure, psig.
- P_f = fuel manifold pressure, in. Hg ga.
- P_n = tachometer pressure, psig.
- P_o = base pressure of temperature transduction, psig.
- P_{s1} = equivalent spring force at computer null, psig.
- P_{s2} = equivalent spring force at computer null, psig.
- T_a = air manifold temperature, °F.
- N = engine speed, r.p.m.
- k_p = conversion factor, psi./in. Hg
- k_{pb} = computer proportional band, decimal.
- k_n = linear speed transduction rate, psi./r.p.m.
- $k_a = k_p/k_{pb}$.
- k_t = linear temperature transduction rate, psi./°F./k_{pb}.
- C = constant for computer null.

With the basic engine hardware in satisfactory operation, the examination of the available mixtures throughout the engine operating range may be made. A typical specitrum of mixtures is shown in Fig. 5. This spectrum represents 1 b.m.e.p. and inlet air temperature at rated speed. Many such spectra will be necessary to obtain all the parameters necessary in the control network design. From each spectrum, one optimum mixture is chosen by the desired operating criteria.

The optimum mixture is shown in Fig. 5 at 32% air-control-valve closure. It is obvious that fuel economy is only one facet of the desired operating criteria. The other facet is best speed regulation. This occurs at a mixture slightly leaner than the best fuel economy and is obtained at a slight sacrifice in fuel economy. The object of automatic mixture control is to duplicate the control variables at any operating condition and in turn reproduce the optimum mixture with its corresponding peak pressure for a check point.

Equation derived. In order to control mixtures with the multivariable input, a correlating equation is derived from the control transfer functions of the form:

$$P_b = P_f \int_0^N N\,(\partial P_n/\partial N)_{BMEP} - P_{s2} + Kp/Kpb \times [P_o + \int_0^T (\partial Pa/\partial Ta)_{Pf} - P_a - P_{s1}]$$

By linearization and simplifying:

$$P_b = P_f + K_n N + K_t T_a - K_a P_a + C$$

The equation becomes the program of a pneumatic analog computer whose output, in turn, becomes the index of mixture control. The equation is illustrated in grid form for rated speed in Fig. 7. A differential proportioned control, similar to the speed-control network, is used to sense index variations caused by the mixture variables and

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drive the air-control valve to return the computed index to its set-point value. The entire automatic mixture and speed-control system is shown in Figs. 2 and 3.

Time constants of the speed network and the mixture network are set so that the speed-control response is very fast relative to the mixture-control response. This places the speed network definitely in the leading role. Undesirable response between the control networks is eliminated by this provision. Small pulsation dampeners are placed in the input signal lines to smooth out noise transients created in the engine piping.

Operating Experience

Application of this automatic control system has been made to 3 engine types on a total of 72 units. A maximum of approximately 2 years' operating experience has shown very satisfactory results. Engine performance has remained optimum continuously without need for control-system maintenance.

Fuel savings have been gained in varying degrees, depending on intake air temperature and b.m.e.p. Fig. 8 shows the relative gain in fuel consumption being reached on controlled operation. Lower intake air temperatures and lower b.m.e.p.'s produce the greatest sav-

The fuel balance valves are then adjusted to balance peak pressures to their optimum value and to the fuel manifold pressure correspondings.

Semimonthly or monthly, a minor tuneup is applied to the controlled engine. This consists of an observation of control inputs and peak pressures which are compared to the optimum values for the load carried.

ing to the control index. Air balance is checked during major tuneups only on a semiannual basis. Only minor tuneups have been found necessary and their magnitude has been very small.

The controlled engines' behavior during sudden storms and rapid load changes is a graphic demonstration of the control system's ability. During storm passages, the controlled engine appears to ignore atmospheric changes as the controls adjust the manifold settings to maintain optimum operation. Rapid load changes appear in a like manner.

Natural gas is Texas' industrial lifeblood

It has replaced crude oil as the fair-haired child of Texas' army of oil operators. And they're spending plenty of money to find it.

BY DR. FRANK J. GARDNER
Exploration Editor

THE STORY of Texas natural gas is one of slow beginning, sudden realization, and burgeoning growth. Perhaps no other spot on earth makes better use of an indigenous energy source than does Texas.

The state holds nearly half (44.8%) of all the natural-gas reserves in the United States and is therefore the biggest source of production. At the same time, Texas is its own best customer, for half of its production is consumed within the state itself.

Gas in Texas performs a multitude of energy chores. It heats, it cools, it generates electricity, produces petrochemicals, and turns drilling rigs; it cooks bread, makes steel, powers kilns, fuels refineries, and often it finds its way back down into the ground to push out more gas and oil for the oil operators of the state.

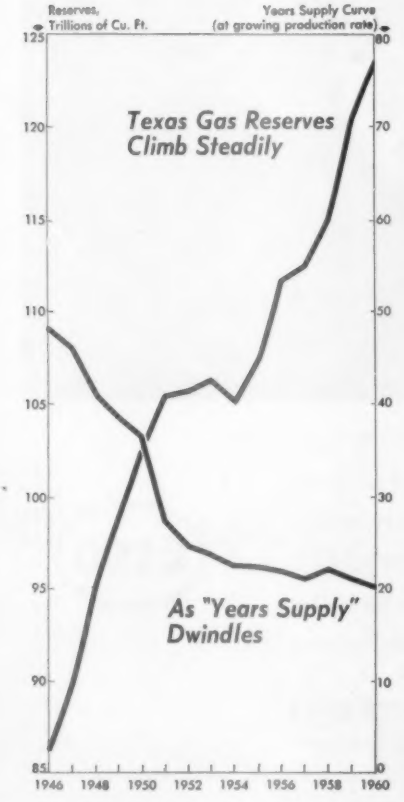
In short, it is Texas' greatest domestic servant and a giant one. Texans consume more of this noble product than all the rest of the world outside the U.S.A.

As the lifeblood of Texas industry, natural gas courses through enough steel veins to reach more than twice around the earth. It reaches into more than 2½ million Texas homes and into approximately 200,000 commercial establishments, and into nearly every major industry.

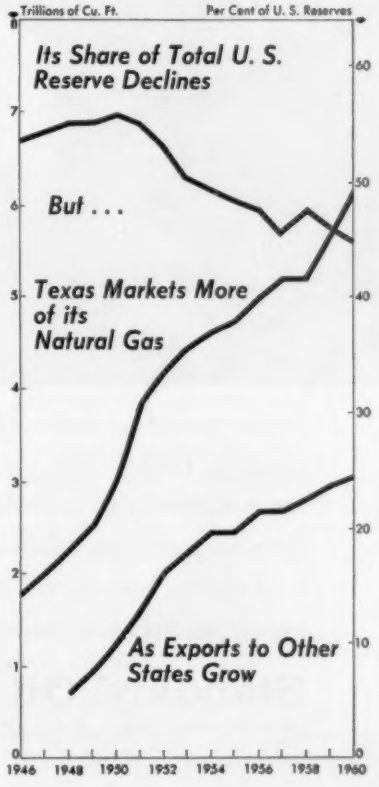
Reserves

How much gas does Texas really have? Latest estimates say 122.5 trillion cubic feet. At the end of World War II, the figure was only 86.4 trillion. So while producing and marketing 48.9 trillion cubic feet during the 15-year period, 1946-61, Texans have continued to build their underground supply by 36.1 trillion cubic feet (Fig. 1 and Table 1).

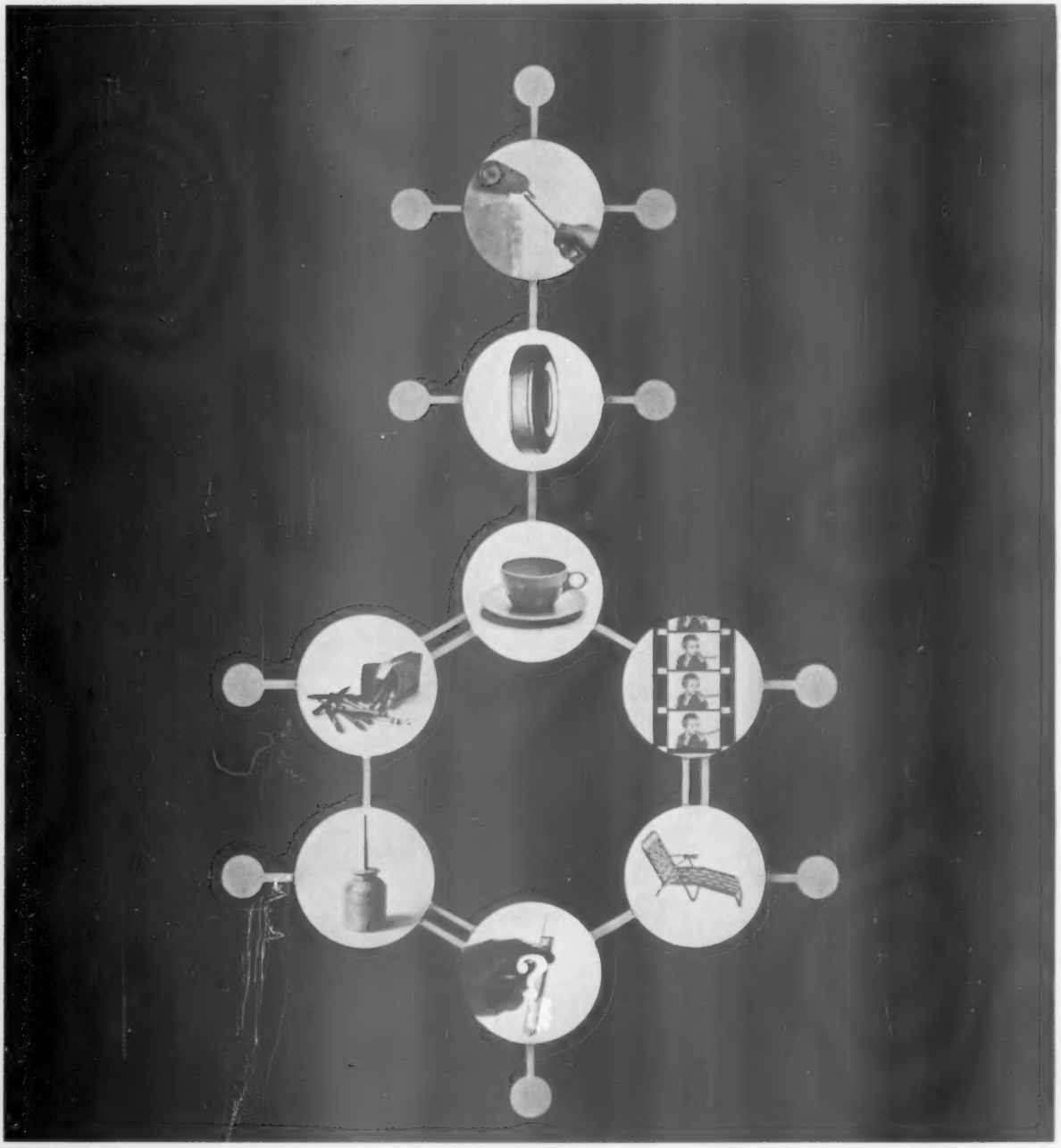
How long can this go on? As marketed production mounts, the "years' supply" figure dwindles. At war's end Texas could have provided U. S. industry with a 48-year supply at the rate of production then. At today's rate of production, however, despite its great increase in reserves, the state can only sup-



TEXAS GAS RESERVES have risen from 86.4 trillion cubic feet in 1946 to an all-time high of 122.5 trillion today. At the beginning of the period, the state held a 48-year supply at the then-current rate of production. At today's marketed production rate of 6.1 trillion cubic feet per day, the supply figure has dwindled to 20.1 years. Fig. 1.



AS GAS RESERVES GREW in other parts of the country, Texas' share of the total reserve fell from 53.8% in 1946 to 44.8% today, but the state still holds the bulk of U. S. reserves. At the same time, marketed production has risen steadily, as have exports to other states. Fig. 2.



"More than three thousand different hydrocarbon compounds have been produced from oil and natural gas. So far, some three hundred of them are commercially important. But scientists believe there are many more useful hydrocarbon derivatives still to be discovered. Out of this test-tube cornucopia will come a multitude of new products to meet the expanding needs of tomorrow."

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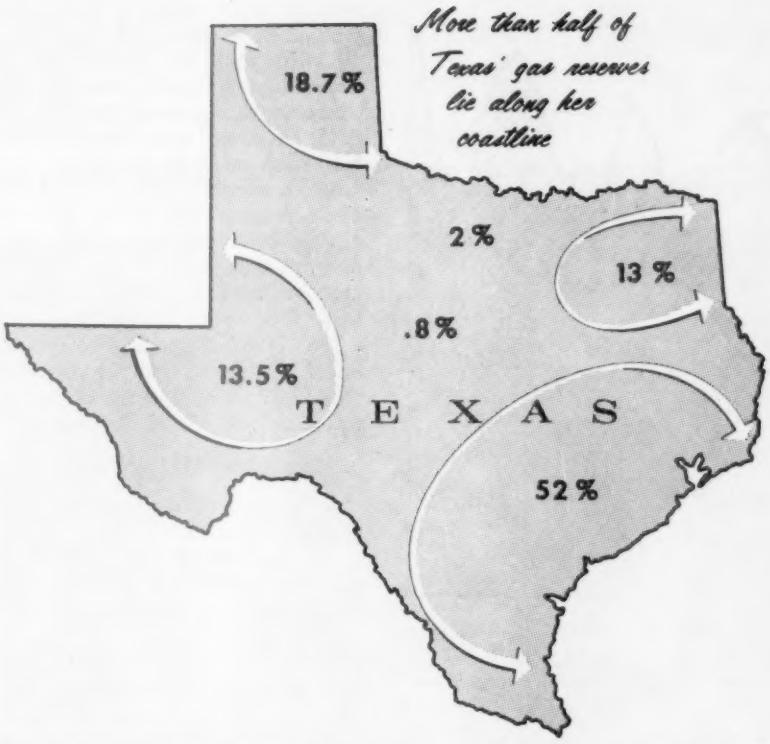


TEXAS GULF COAST holds most of Texas' gas reserve (more than half) and about one-quarter of the national reserve is concentrated in this area. Second-largest region of the state is the Panhandle with 18.6%, followed by West Texas, East Texas, and North Central Texas. Fig. 3.

ply its market for a little more than 20 years.

This doesn't mean that Texas is "running out of gas," for during the past few years Texans have eyed the situation closely and have undertaken a concerted campaign all over the state to uncover new reserves of this valuable gas. While oil has become a drug on the market, natural gas has become the exclusive Target No. 1, and millions of dollars each year now go into gas exploration alone.

While Texas is the biggest single source of U. S. gas reserves, successful gas hunts in other states have reduced her proportionate share of the total U. S. reserve from 53.8% in 1946 to a current 44.8% (Fig. 2).

Meanwhile, marketed production of Texas gas has risen steadily and exports to other states have increased from 0.6 trillion cubic feet in 1948 to more than 3 trillion in 1960.

TABLE 1—TEXAS RESERVES VS. MARKETED PRODUCTION OF NATURAL GAS
(1946-1960)

Year	Reserves as of Dec. 31 (trillions of cu. ft.) Source: AGA	% of U. S. total	Marketed production (trillions of cu. ft.) Source: OGJ	Years supply at demand rate
1946	86.4	53.8	1.8	48.0
1947	90.0	54.2	2.0	45.0
1948	95.7	55.0	2.3	41.6
1949	99.2	55.0	2.6	38.2
1950	102.4	55.2	3.1	33.0
1951	105.6	54.4	3.8	27.8
1952	105.7	52.9	4.2	25.2
1953	106.5	50.4	4.4	24.2
1954	105.1	49.6	4.6	22.8
1955	108.3	48.4	4.7	23.0
1956	112.7	47.4	5.0	22.5
1957	113.0	45.8	5.2	21.7
1958	115.0	46.9	5.2	22.1
1959	120.5	45.9	5.7	21.1
1960	*122.5	44.8	6.1	20.1

*Estimated by The Oil and Gas Journal.

TABLE 2—TEXAS GAS RESERVES BY DISTRICT

District	Per Cent	Estimated Reserves (trillions of cu. ft.)
1	0.5	0.6
2	6.5	8.0
3	25.0	30.6
4	20.0	24.5
5	1.0	1.2
6	12.0	14.7
7-B	0.8	1.0
7-C	2.0	2.5
8	11.5	14.1
9	2.0	2.4
10	18.7	22.9
TOTAL	100.0	122.5

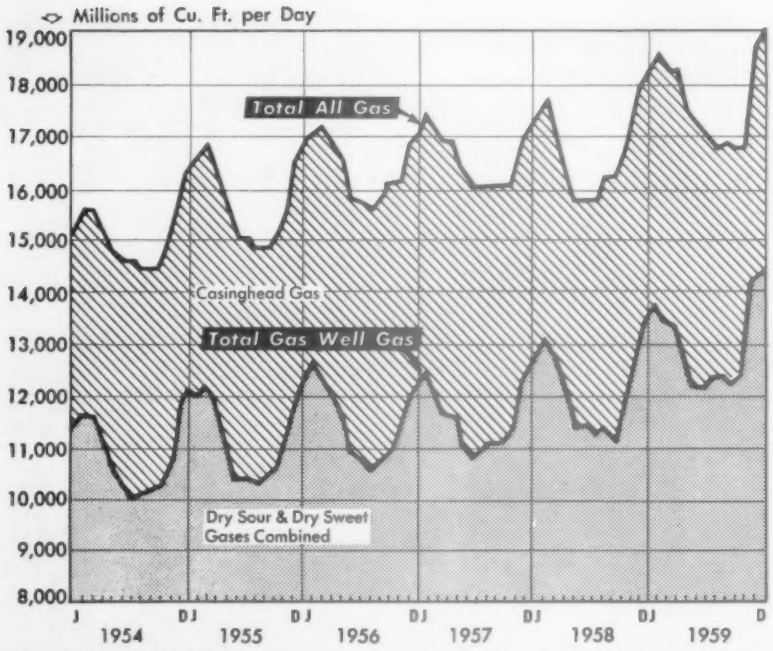
Habitat

Where is all this gas in Texas? The tables and charts accompanying this article are very revealing. At first thought, most people believe that the great Panhandle fields must be Texas' greatest gas treasure.

Not so. A breakdown of reserves by districts (Fig. 3 and Table 2) reveals that more than half (52%) of all Texas' gas reserves lie along her coast line in Railroad Commission Districts 1, 2, 3, and 4. Second-largest gas depository is the Panhandle (District 10), followed by West Texas (Districts 7-C and 8), East Texas (Districts 5 and 6), and West Central and North Texas (Districts 7-B and 9).

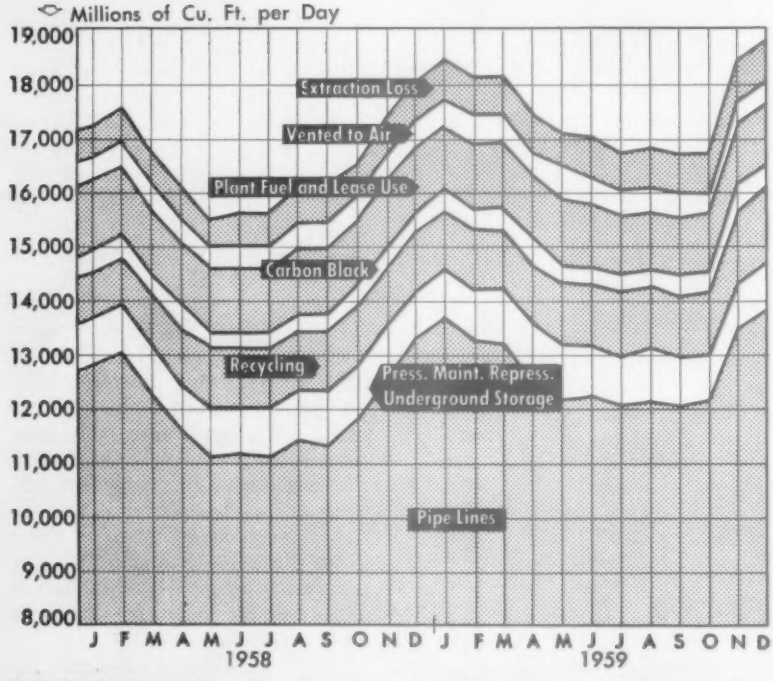
Studies have shown that approximately 65% of all these reserves are nonassociated gas (exclusively gas reservoirs) and the other 35% are associated with or dissolved in crude oil. Significantly this nonassociated gas is largely concentrated in about 26 giant gas fields, while the associated gas is concentrated in about 88 giant oil fields which have an estimated ultimate recovery of about 24 billion barrels and represent 62% of all Texas crude reserves.

Where it comes from . . . Texas gas today comes from 16,771 gas wells and 192,627 oil wells sprinkled all



TOTAL GAS PRODUCTION has risen steadily in Texas since the end of World War II. Nearly one-third of this is casing-head gas while the remainder comes from pure gas wells. (Adapted from 1959 annual report, Railroad Commission of Texas.) Fig. 4.

"Since the industry became aware of the great value of natural gas, it has jealously guarded established reserves and conserved them."



VARIOUS USES to which Texas natural gas is put are shown in this diagram. Most of the gas goes into pipelines, both intrastate and interstate. Next largest amounts are used for recycling, plant fuel, lease use, etc. (Adapted from 1959 annual report, Railroad Commission of Texas.) Fig. 5.

over the state. About 27% of this production is casing-head gas from oil wells while the other 73% is gas-well gas (Table 3 and Fig. 4). There are more than 2,500 pure gas fields alone, and these contain about 6,500 separate gas reservoirs.

What becomes of all this gas? Fig. 5 provides the answer. Most of it goes into pipelines for distribution to industry and homes. Smaller amounts are used for plant fuel and lease use. Some is used to make carbon black; a good bit of it goes into recycling and pressure-maintenance plants, while some is vented to the air and lost to shrinkage.

A Changed Approach

Since the industry became aware of the great value of natural gas as a source of energy, it has jealously guarded established reserves and cooperated with government authorities to conserve them. There was a day back in the 1920's when gas was an unwanted byproduct and vast amounts of it were blown to the air. But that day is a black page in oil history, and today it is a laughable one. Gen. Ernest O. Thompson, of the Railroad Commission of Texas, recalls that period as follows:

"Billions upon billions of feet of gas were flared in the Panhandle field. Then finally we got our Chamber of Commerce busy looking for industries to come and fill our prairies with smokestacks, using our gas for fuel. We sent our emissaries all over the U. S., trying to get industries to move to Amarillo, to take advantage of our clean, cheap fuel. But none were interested.

"We spent $60,000 advertising this abundance of gas in the world's largest gas field. We even offered gas free for 5 years to any industry that would come to Amarillo and employ 50 or more people. None came, even for free."

What a change we see today! Now, natural gas is the principal target of the drilling bit in Texas from El Paso to Houston, from the Panhandle to Brownsville. Twenty years ago, one-fifth of all Texas gas was wasted; today only about 3% is blown away. Gas-conservation plants dot the landscape of Texas. There are 270 such plants for stripping the liquids out of the gas and 28 cycling plants to return it to the

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NORWAY'S FIRST MAJOR REFINERY

Another grass roots refinery—this one in Norway—has been added to the string completed by Bechtel. Designed to meet the rapidly increasing demand for Esso petroleum products in Scandinavian countries, it is located at Slagen, near Tonsberg, Norway. The project was built on schedule and under the budget.

The new 42,200 barrels-per-day refinery—a hydroskimming type designed by Esso Research and Engineering Company—is owned by A/S Esso-Raffineriet, Norge, a subsidiary of Standard Oil Company of New Jersey.

Bechtel supervised engineering and procurement. Construction was performed by Bechtel in a joint venture through the medium of A/S Bechtel-Sverdrup Norge.

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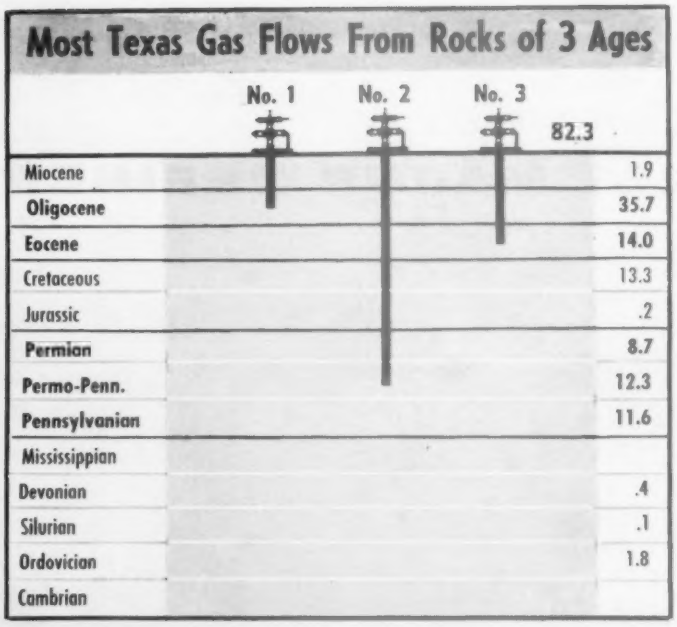

RICHEST GAS RESERVOIRS in Texas are of Oligocene, Eocene, and Permo-Pennsylvanian age. The Oligocene-Eocene fields lie along the Gulf Coast, while the Permo-Penn fields are concentrated in West Texas and the Panhandle. Fig. 6.

"Despite the healthy condition of its gas industry today, Texas still has a great deal of proven natural gas that is not being sent to market."

TABLE 3—SUMMARY OF GAS PRODUCTION IN TEXAS

Year	Number of gas wells produced	Gas-well gas produced M.c.f.	Casing-head gas produced M.c.f.	Total gas produced M.c.f.
1936	2,717	575,275,000	269,463,000	844,738,000
1937	2,943	658,713,000	335,175,000	993,888,000
1938	3,158	705,908,000	393,367,000	1,099,275,000
1939	3,246	872,286,000	442,773,000	1,315,059,000
1940	3,403	1,087,089,000	452,238,000	1,539,327,000
1941	3,553	1,382,830,000	427,462,000	1,810,292,000
1942	3,685	1,508,794,000	402,328,000	1,911,122,000
1943	3,800	1,683,920,809	438,647,209	2,122,568,018
1944	3,962	1,907,704,332	527,013,593	2,434,717,925
1945	4,658	2,065,266,423	599,911,322	2,665,177,745
1946	5,122	2,098,867,220	664,545,023	2,763,412,243
1947	5,438	2,231,430,080	706,070,607	2,937,500,687
1948	5,750	2,540,917,386	707,303,721	3,248,221,107
1949	6,493	2,739,790,600	770,732,048	3,510,522,648
1950	7,310	3,099,606,096	924,570,897	4,024,176,993
1951	8,296	3,518,486,197	1,155,049,259	4,673,535,456
1952	9,202	3,779,106,990	1,310,269,791	5,089,376,781
1953	10,257	3,835,635,847	1,479,135,184	5,314,771,031
1954	11,224	3,955,492,811	1,555,169,157	5,510,661,968
1955	11,793	4,061,169,733	1,679,288,713	5,740,458,446
1956	12,503	4,196,274,738	1,808,459,532	6,004,734,270
1957	13,681	4,209,022,841	1,827,840,669	6,036,863,510
1958	15,349	4,383,259,164	1,666,868,115	6,050,127,279
1959	16,771	4,707,673,353	1,714,236,548	6,421,909,901
		61,804,519,620	22,257,917,388	84,062,437,008

earth where it is needed for pressure maintenance.

Shut-in Reserves

Despite the healthy condition of its gas industry today, Texas still has a great deal of proven natural gas that is not being sent to market. Perhaps the fields are isolated from existing outlets, or perhaps the potential production is not sufficient to warrant pipeline construction. Texas today has more than 6,600 shut-in gas wells (Table 5).

On the Gulf Coast . . . As an example of this untapped reserve, the Gulf Coastal Districts 1, 2, 3, and 4 provide a good picture (Table 4). A recent study shows that in District 1 there are 66 wells in 42 different fields without an outlet. In District 2 there are 612 wells in 254 different fields, and in District 3 there are 364 wells in 174 fields; the champion, as far as unconnected fields goes, is District 4 with 891 shut-in gas wells representing 356 different fields. The grand total in these four districts is 1,933 shut-in wells in 826 fields.

Of all the counties involved in Table 4, it is interesting to note that Duval (145) and Jim Wells (123) boost more unconnected wells than any other counties. Victoria County with 112, Jackson County with 109, and Starr County with 103 are next in line.

And in other areas . . . There are other parts of Texas with unconnected reserves (Tables 5 and 6). The figures in Table 6, it will be noted, do not agree with those just cited for Districts 1, 2, 3, and 4. The Table 6 figures are taken from the 1959 annual report of the Railroad Commission of Texas and may well include many early gas completions now considered noncommercial; hence the discrepancy. They do, however, again reflect that District 4 has a greater percentage (44.5%) of shut-in completions than any other. In close order behind District 4 come Districts 8, 7-B, and 7-C, with 40 to 44% not producing.

Operators in North Central Texas are doing something about the shut-in gas reserves there. The West Central Texas Oil and Gas Association recently made a survey of unconnected wells and came up with

revolutionary new technique increases flow efficiency, provides perfect internal surface for painting and reclaims old lines ready to be abandoned

cleans up to 15-mile sections

Sandblast pipelines in place in lengths up to 15 miles (depending on diameter) in one or two hours' time. After sandblasting, the internal surface of the pipe approaches Bureau of Mines projection for super-finished smooth pipe surface.

This process will and has removed practically all known types of internal incrustations which foul-up the inside walls of pipelines carrying various liquids and gases.

Be sure to see the article on THE NEW SANDBLASTING TECHNIQUE, complete with test results, in this issue of THE OIL & GAS JOURNAL.

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Table 5—Texas Gulf Coast Provides a Picture of Idle Gas Wells

	Total shut-in gas wells	In this many fields
District 1		
Atascosa	6	3
Caldwell	1	1
Dimmit	20	9
Frio	5	4
La Salle	4	4
Live Oak	4	1
Maverick	2	2
Medina	1	1
McMullen	11	9
Val Verde	1	1
Wilson	4	2
Zavala	7	5
	66	42
District 2		
Bee	86	44
Calhoun	52	18
Dewitt	24	11
Goliad	59	31
Jackson	109	39
Karnes	5	4
Lavaca	26	8
Live Oak	56	35
Refugio	83	24
Victoria	112	40
	612	254
District 3		
Austin	4	2
Brazoria	43	16
Brazos	1	1
Burleson	2	1
Chambers	17	11
Colorado	27	14
Fort Bend	6	4
Galveston	25	14
Grimes	1	1
Hardin	20	10
Harris	24	10
Jasper	1	1
Jefferson	71	22
Liberty	14	9
Madison	1	1
Matagorda	48	23
Montgomery	9	5
Newton	3	3
Orange	7	2
Polk	5	4
San Jacinto	2	2
Tyler	2	2
Wharton	31	16
	364	174
District 4		
Aransas	17	8
Brooks	41	14
Cameron	6	3
Duval	145	68
Hidalgo	64	31
Jim Hogg	59	23
Jim Wells	123	33
Kenedy	25	10
Kleberg	32	10
Nueces	92	40
Refugio	4	1
San Patricio	65	24
Starr	103	46
Webb	41	20
Willacy	11	5
Zapata	63	20
	891	356
Grand Total:		
1933	826	

Source: Research Study of Shut-in Gas Wells in Texas Railroad Commission Districts 1, 2, 3, and 4, published by Austin Oil and Gas Publishing Co., Austin, Tex., 1961.

a total of 102 wells belonging to 60 different operators. WCTOGA estimates that these wells represent a recoverable reserve of 750 billion cubic feet in the following counties: Brown, Callahan, Coleman, Comanche, Eastland, Erath, Jack, Palo Pinto, Parker, Stephens, Wise, and Young.

Here is a typical theater of gas interest today. The West Central Texas operators in the past 2 years have practically abandoned the search for oil and are vigorously looking for natural gas instead. They are drilling deeper and reentering old oil failures which may have had good gas showings. The results have been most gratifying, and WCTOGA now is dickering with several possible purchasers for sale of these reserves. The digging is shallow, lease costs are moderate, and when ample outlets are secured, we shall see a greatly stimulated drilling program in these North Central Texas counties. There are about a half million acres still to be explored.

This is just one example of what goes on in Texas today. We can look for more of it in the future in such untapped areas as the Delaware basin, East Texas, Southwest Texas, and the Gulf Coastal Plain. For natural gas has displaced crude oil as the fair-haired child of Texas' army of oil operators. And they're spending plenty of money to find it.

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"Texas Gas Reserves Gain 3 Trillion Cubic Feet," by Charles A. Breitung: The Oil and Gas Journal, April 16, 1956, p. 282.

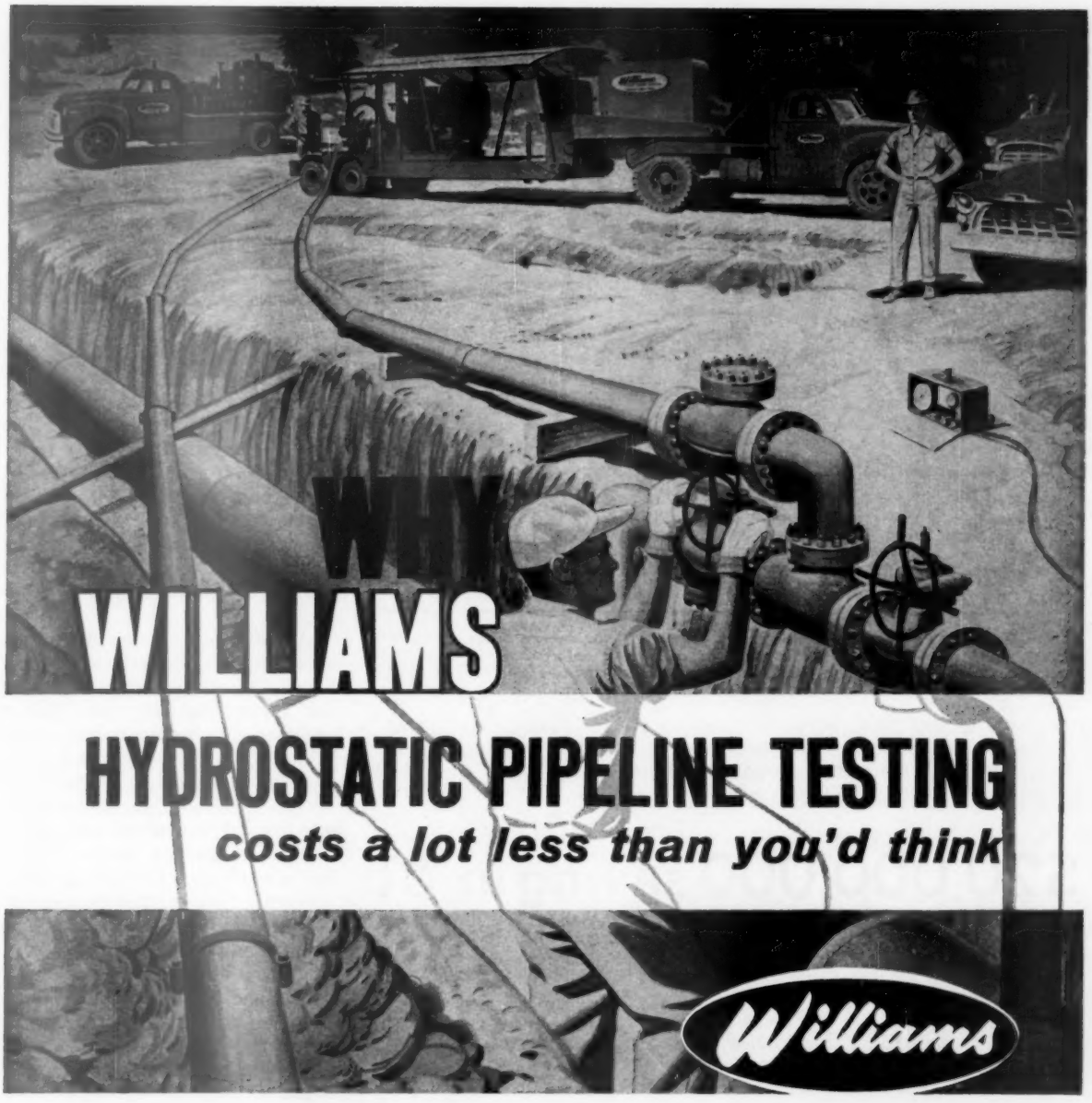
"Texas Gas . . . Where Will It Come from Tomorrow," by Frank J. Gardner: The Oil and Gas Journal, June 18, 1956, p. 180.

TABLE 5 — STATE-WIDE PICTURE OF SHUT-IN GAS WELLS IN TEXAS

Year	No. producing gas wells	Total No. gas wells	Shut-in wells
1952	9,287	12,136	2,849
1953	10,257	13,367	3,110
1954	11,132	14,578	3,446
1955	11,793	15,612	3,819
1956	12,589	17,399	4,750
1957	13,850	19,302	5,452
1958	15,349	21,335	5,986
1959	16,771	23,385	6,614

TABLE 6—DISTRICT BREAKDOWN ON TEXAS' SHUT-IN GAS COMPLETIONS
(As of January 1, 1960)

District	Number wells	Producing	Shut in	Per cent shut in
1	362	250	112	30.9
2	3,296	2,208	1,088	33.0
3	3,087	2,148	939	30.4
4	5,081	2,818	2,263	44.5
5	279	193	86	30.8
6	2,210	1,789	421	19.0
7-B	961	578	383	39.9
7-C	494	297	197	39.9
8	1,059	593	466	44.0
9	1,018	732	286	28.1
10	5,538	5,165	373	6.7
	23,385	16,771	6,614	28.3



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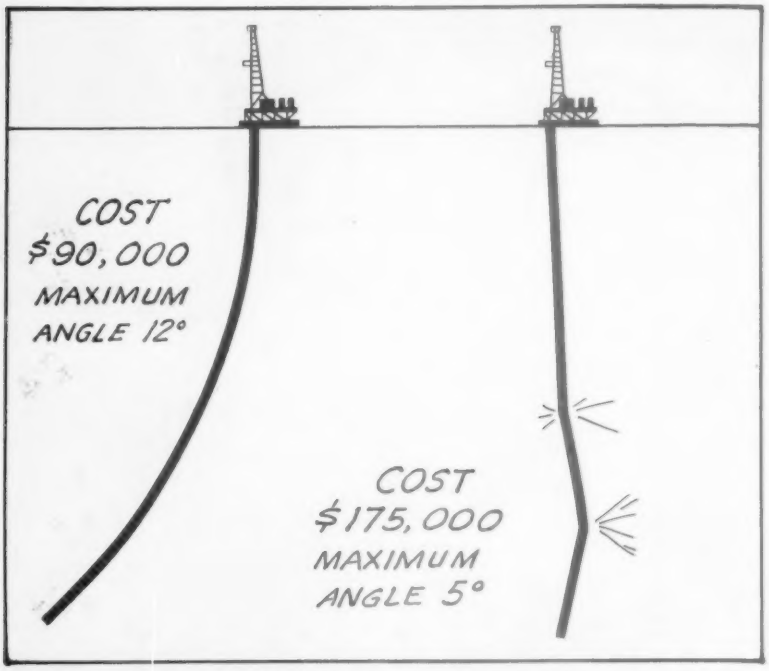


PREMIUM FOR NEAR-VERTICAL HOLE is often 100% or more. And, the extra money spent in drilling is no guarantee that there'll be no trouble. In this hypothetical example, the smooth 12° hole is not only cheaper but is less likely to have trouble since 5°-maximum hole has dog legs resulting from attempts at straightening.

In drilling crooked-hole formations . . .

$20,000,000 saving in '61

But—Another $20,000,000 awaits pocketing

BY ED McGHEE
Drilling Editor

THERE'S A $20,000,000 saving for drilling contractors and oil companies in the new wells they drill this year in the United States. This imposing sum is a bonus resulting from advances of the past 5 years in the science of drilling straight holes through crooked-hole formations.

Probably another $20,000,000 waits to be pocketed. This amount might be cut off the over-all drilling bill if contractors and operators exploit the latest knowledge on crooked-hole problems. Much of this saving could be made simply by rewriting drilling contracts to reflect recent advances.

Here's what well-informed drilling men think might be put into drilling contracts to save money in crooked-hole country:

1. Old limits on hole deviation such as 3° maximum, 5° maximum, or 1° deviation per 1,000 ft. of hole depth should be abandoned.

2. New limits on hole deviation should be written solely for the purpose of preventing troublesome dog legs.

3. Surface location should not be fixed definitely before contract is let. The drilling contractor should be able to pick the best location on the lease which will allow him to bottom the hole in the desired downhole area.

If contracts were written with these provisions, there'd be advantages for both oil company and contractor:

1. The oil company would get a cheaper well because it would be faster and cheaper to drill. The hole would be just as cheap (or cheaper) to produce.

2. The contractor could be more certain of his cost and could bid lower. He would not labor under threat of penalties arising if the hole suddenly went "wild"—gaining more angle than the contract allowed.

Where credit is due. The above conclusions find general agreement in the group most directly responsible for saving that 20,000,000 of the oil industry's 1961 dollars. That group is the Crooked-Hole Subcommittee of the Rotary Drilling Committee of the American Association of Oilwell Drilling Contractors.

At a January meeting of the subcommittee, its present chairman, Stanley Moore, president of Drilco Oil Tools, Midland, Tex., quoted estimates of what the industry pays trying to drill straight holes in crooked-hole country. In the 1954-55 period, he said, the figure likely was about $50,000,000 annually.

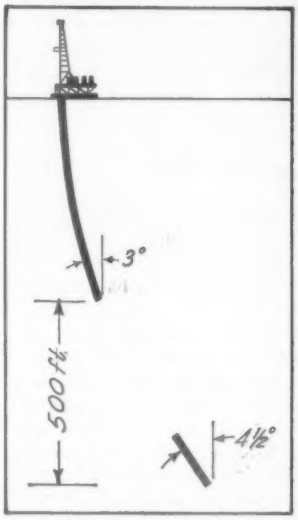
Moore estimates that the figure has now been cut to about $30,000,000.

Most of the saving results from a new ability acquired by drillers. They are now able to pick drill collars and to place stabilizers that promote drilling the hole at the fastest possible rate without its going beyond contract limit on hole angle.

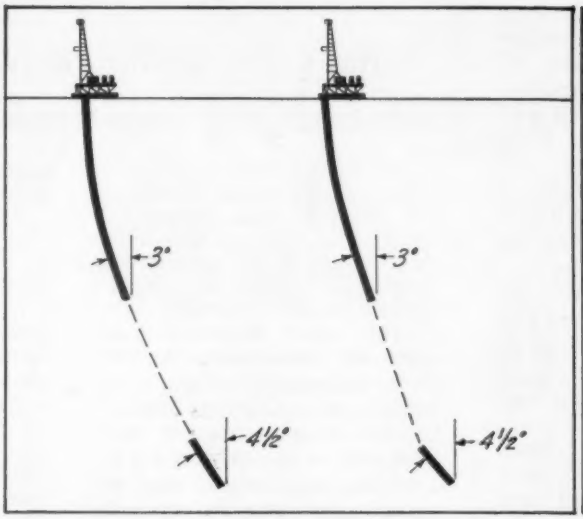
Where did drillers gain their new advantage? From charts and tables developed in late years for this purpose. These money-saving guides had their beginning in the theoretical investigations made by two men: Arthur Lubinski, of Pan American Petroleum Co., Tulsa, and Henry Woods, of Hughes Tool Co., Houston. (OGJ, May 31 and June 7, 1954, and Apr. 4, 1955).

Woods' and Lubinski's original charts were translated into table form by H. M. Rollins. These tables now are included in the AAODC's Toolpusher's Manual and are in general use throughout the drilling industry.

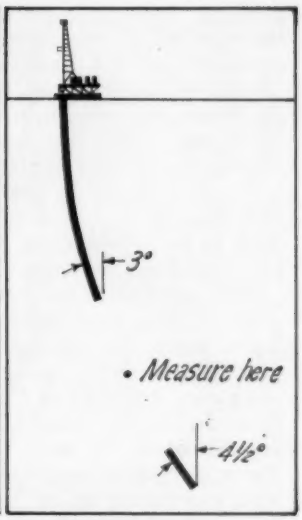
The recently acquired knowledge



1. **SLOPE MEASUREMENTS** in hypothetical well. There's an increase of 1½° in a 500-ft. interval. Contract allows 1° change between surveys. Has the contract been violated?



2. **WHICH IS IT—SMOOTH OR DOG LEG?** If all the 1½° increase has taken place in a short space, there may be a dog leg too severe to accept. If the buildup in angle has been gradual, drilling can continue without trouble. Sharper dog legs may be accepted near total depth than near surface.



3. **TO FIND** if hole is acceptable, measure at midpoint in section. If reading is 4°, change in angle doesn't exceed contract. If reading is 4¼°, take readings at 100-ft. intervals to further ascertain how abrupt is the change of angle.

about picking drill collars and placing stabilizers attacks only one part of the problem: permitting the fastest drilling possible within the limits of the contract. In effect, life was being made easier under a bad situation but nothing was being done directly to make the situation itself any easier.

Sacred cows abound. The requirements on hole angle written into drilling contracts are an accumulation of some 50 years. During this time, drillers and producers had many troubles with wells which they, rightly or wrongly, attributed to the holes being crooked. For lack of better information, it became the popular notion that a perfectly vertical (improperly called "straight") hole would be the safest to drill and produce.

Many companies settled on 2° deviation from vertical as being the maximum allowable. Others accepted 3°. All this while, no one had a really sound basis for answering the basic question: "How near vertical (improperly, "straight") does a well need to be?"

Actually, there's a difference between a "vertical" hole and a geometrically "straight" hole. Take the case of a well which is inclined 2° toward the east. Suppose that it

TABLE 1—MAXIMUM CHANGE OF ANGLE BETWEEN 30-FT. SPACED SURVEYS TO PREVENT FATIGUE FAILURES OF BOTH DRILL PIPE AND DRILL-COLLAR CONNECTIONS, AND TO KEEP ACCEPTABLE FORCE BETWEEN TOOL JOINTS AND HOLE WALL

(4½-in. 16.6-lb. per foot drill pipe. Total depth, 12,000 ft.; 810 ft. of 6¼-in. drill collars; 7⅞-in. hole)

Depth interval (ft.)	For inclinations which are increasing with depth	For inclinations which are decreasing with depth
4,000- 5,000	½°	½°
5,000- 6,000	½°	½° for inclinations up to 10° ¾° for inclinations between 10° and 30°
6,000- 7,000	½°	½° for inclinations up to 10° ¾° for inclinations between 10° and 30°
7,000- 8,000	½°	½° for inclinations up to 5° ¾° for inclinations between 5° and 30°
8,000- 9,000	*½° †¾°	½° for inclinations up to 5° ¾° for inclinations between 5° and 20° 1° for inclinations between 20° and 30°
9,000-10,000	¾°	¾° for inclinations up to 10° 1° for inclinations between 10° and 30°
10,000-11,000	1°	1° for inclinations up to 20° ‡1¼° for inclinations between 20° and 30°
11,000-12,000	1¼°	1¼° for inclinations up to 10° ‡1¼° for inclinations between 10° and 30°

*For inclinations up to 20°. †For inclinations between 20° and 30°. ‡For these conditions drill collars must not be rotated for any prolonged period of time under full tension in the dog leg.

Taken from "Maximum Permissible Dog Legs in Rotary Bore Holes" by Arthur Lubinski and presented at 1960 fall meeting of Society of Petroleum Engineers of AIME.

suddenly turns and drifts toward the west at 2°. Most field people would still call it a straight hole because it is close to vertical. Actually, the hole is not straight; it has a 4° (2°E plus 2°W) dog leg. Being vertical is not being straight.

It's now becoming clear that a hole need not be vertical but it does need to be "straight" in that dog legs should not be too severe.

This judgment would have come sooner if the industry had been willing to accept the experience of its directional drillers. A number of companies, largely in California, have drilled and produced high-angle holes for 20 years or more. These companies completed many wells successfully at 30° and more from vertical. They found that the high angles in themselves cause little, if any, trouble. Only when there is a rapid change in hole angle—a dog leg—is there any unusual difficulty with the high-angle holes.

Oil companies would have begun using more rational hole angles 20 years ago if they had listened to the advice of some of their own engineers. This fact came to light as a result of some of the work of the Crooked-Hole Committee. The group is compiling a bibliography of writings on their subject. They found articles as early as 1932 written by oil-company engineers and urging that the 2° and 3° contracts be abandoned.

In recent years, many companies have liberalized their contract limits. Some accept a maximum of 5°. Others have gone so far as to allow 1° of deviation for every 1,000-ft. of hole depth, or even more. Such absolute limits have at least one advantage. As Moore says, they are easy to administer. There's no uncertainty about them and no thinking is required.

Unfortunately, the more liberal allowances have themselves grown into new "sacred cows". Take the case where the driller exceeds these limits. Quite often, he is forced to plug back the hole and whipstock it nearer vertical. Result is usually a bad dog leg.

Dog legs to blame. Now, the experience of the slant-hole drillers has found solid scientific backing. Only last fall, Arthur Lubinski added again to his work on crooked hole.[1] This time he has focused on the dog legs. And, he has devised means to calculate whether or not a given change in hole angle will cause trouble.

Lubinski's latest work is too involved to outline here, but the conclusions from it may be put into drilling contracts immediately. Based on this study, many members of AADOC's subcommittee on Crooked-hole Drilling believe the drilling contract should have only two requirements on hole angle:

1. The hole should be bottomed as necessary (on the lease or within some preset area).
2. Changes in hole angle shouldn't exceed the limits of safety.

The first requirement recognizes that it is, after all, the bottom of the hole and not the surface location which is important and must be placed properly. As long as the borehole does not cross lease lines, known faults, or some other boundries, there's no need for its precise location to be an issue. In effect then, the wells would be "target drilled".

Contracts are already being let in several areas for target drilling. In these cases, the drilling contract sets out the area within which the well bore should be when it reaches some depth. Then, the contractor

What's the drilling contractor's concern with hole angle?

THERE'S no more graphic illustration of why contractors are vitally concerned with crooked hole than in the following tale. It was told by one of the contractors at the January meeting of AADOC's Rotary Drilling Committee.

This actual, documented case illustrates several important facts:

1. Straightening a hole from some high angle (in this case 11°) back to some low angle (2° here) can cause an extremely bad dog leg.

2. Dog legs, whether from this or any other cause, are responsible for almost all the troubles associated with hole angle.

3. Dog legs are just as costly to contractors as to operators.

4. A high-angle hole with smooth changes in angle is far better than a low-angle hole with rapid changes in angle (dog legs).

Scene of the story is the contractor's rig on a Wyoming location. Since the hole was a wildcat and since the rig was drilling on day-work rates, the contract made no stipulation about maximum hole angle. The operator was paying the contractor rental on the drill pipe. Prior to spudding the hole, the string was inspected and all bad joints discarded.

After drilling started, hole angle drifted off gradually until it was 11° at 5,000 ft. In spite of this "high" angle, there was no indication of any difficulty. Then, at this depth, the well apparently crossed an unconformity and the hole took a sudden turn back toward vertical. Within a very short distance, hole angle was only 2°.

According to some, this natural return to a "straight" hole should have been a blessing. It wasn't. It created the curse of a bad dog leg.

But, since the operator wasn't greatly concerned about hole angle in itself, he ordered drilling continued through the dog leg without any action to remedy it. And drilling did continue to a total depth near 15,000 ft. Troubles arising from the dog leg continued to multiply as the hole deepened. Toward total depth, there was as much as 8 or 9 rounds of torque in the drill string while rotating. There was heavy drag whenever the bit was pulled off bottom.

At total depth, the drill pipe was inspected again. About 85% of it had to be discarded. There were fatigue cracks in almost every joint.

The contractor junked about $150,000 worth of drill pipe. He received about $15,000 rental on it.

Not surprisingly, the contract on the next well was different. Contractor, operator, rig, and area were the same. However, this time the deviation clause in the contract said that the operator would pay double rental on the drill pipe if hole angle went higher than a set amount.

This may well be the first time a drilling contract was written expressly to protect the contractor rather than the operator. Actually, according to Lubinski, the clause should have set out the maximum permissible change of angle rather than the angle itself.

is free to choose the surface location to take advantage of the natural drift of the formations. As long as the hole stays "on course", he can apply as much weight as needed to drill quickly and cheaply.

Contractors say the downhole target should not be too small. In some extreme cases, the target has been hardly larger than 100 ft. by 100 ft. at a depth of 12,000 ft. Such pin-point accuracy makes the hole, in effect, a directional drilling job. So many directional surveys and whipstocks are needed that all the advantages of target drilling disappear.

The second requirement — that changes in hole angle not exceed limits of safety—is harder to pin down.

Collar size not fixed. Some have said that the drilling contract should specify what size drill collars should be used and where stabilizers should be placed. Idea is that the program would be good enough that no intolerable dog legs would be created. As one puts it, "Any dog leg in an 8¾-in. hole that three 7¾-in. collars will go through is mild enough not to cause trouble."

Contractors generally oppose such provisions. If their bid price is competitive, they say, it will naturally follow that their drill-collar and stabilizer program will be good. Too much freedom would be lost if contracts specified collar size, most contractors believe.

Most operators too oppose including collar size and stabilizer placement in the drilling contract. As one points out, "It might make us responsible for the fishing jobs that result from the collar program we select. Besides, the contractor may be willing on his own to use a better collar size than we would normally feel free to require of him.

The solution most seem to prefer is setting out in the contract only the maximum change in angle which can be tolerated.

More at bottom than top. Drill pipe at the top of the hole is under a heavy tensile load from the weight of the string hanging below. Rotating the pipe through a dog leg speeds up fatigue failure. And, the sharper the dog leg, the higher the fatiguing effect. It follows that a sharper dog leg can be tolerated at the bottom of the well than at the top.

This conclusion is borne out by the latest work of Lubinski. From this work, one may prepare tables of the maximum changes in angle which may be accepted at various depths for any combination of hole size, pipe size, collar size, and average hole angle. Making such a table requires lengthy engineering work; it doesn't seem practical to perform such a task every time a drilling contract is being prepared. However, a large number of typical cases are now being solved under the supervision of Jack Marsee, of Loffland Brothers Co., and Lubinski believes that the work will produce a few simplified tables (maybe three or four) which can be used for almost all conditions.

Lubinski suggests that a typical example might be:

Depth interval—	Maximum change allowable in hole angle between two successive surveys
First 1,000 ft. above bottom	1¼°
Next 1,000 ft. higher	1°
Next 1,000 ft. higher	¾°
Remaining distance to surface	½°

Since the maximum allowable dog leg depends on distance from the surface, it is simpler to write the contract "from the bottom up". That is, the maximum allowable dog leg is the same for the first 1,000 ft. off bottom in any well regardless of whether it is 5,000 or 15,000 ft. deep.

When to survey. Members of the Crooked-Hole Drilling Subcommittee say that the contract should continue to set how often slope tests are to be made. There's certainly no need, most believe, for a slope test every 100 ft. Rather, here's an example case to show how slope surveys might be handled.

Say that the slope tests are required by the contract every 500 ft. Then, assume that the hole is drilling in an interval where a 1° change is allowed in hole angle between surveys. Suppose that the hole angle has increased 1½° from the time of one slope test until the next one 500 ft. later. What to do? Go back and see exactly how that 1½° change occurred.

The fact that the change in hole angle over a surveying interval is more than the contract amount doesn't necessarily mean that the hole is unacceptable. It means, rather, that more closely spaced surveys are needed in the interval. Such surveys will generally show that the dog leg is gradual over the entire 500 ft. That is, there may be no more than a 1° change in any subinterval. Then, drilling can continue in the knowledge that the contract has not been violated. If, for instance the survey run in the middle of the 500-ft. interval shows the changes in the two subintervals are 1° and ½°, then drilling may proceed.

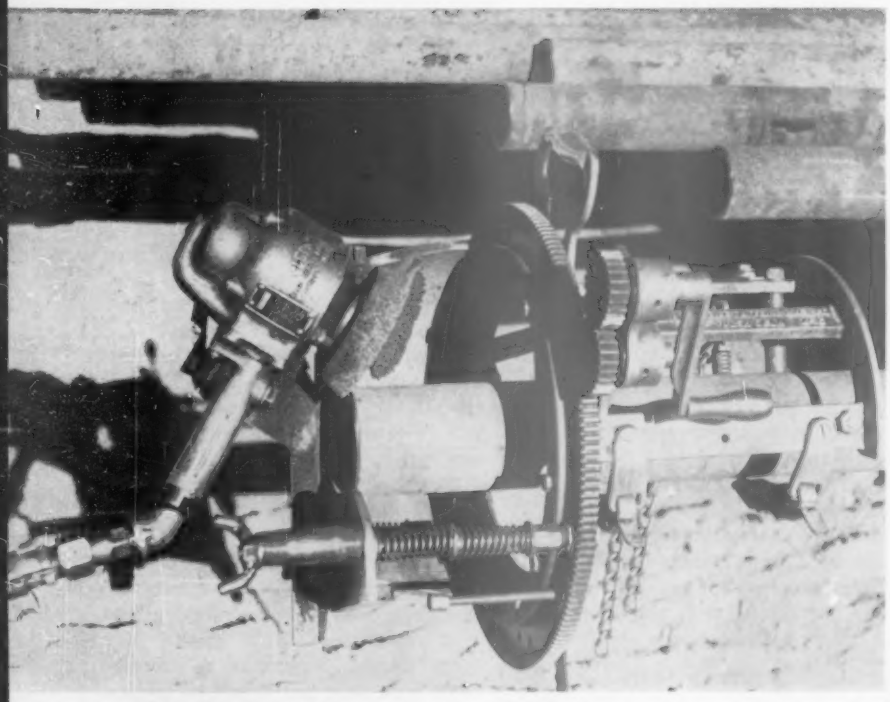
Suppose, on the other hand, that most of the 1½° change had taken place in a single 250 ft. of hole. Obviously, this is more than the contract sets out. Should the hole be plugged back and straightened? Not immediately. That 250-ft. interval should be surveyed still more closely. A slope test should be taken at smaller and smaller intervals, the shortest interval being 30 ft. If, at no one of the new subintervals, hole angle changes no more than 1°, drilling may proceed.

Needed: new instruments. Our present hole - direction instruments tell us the exact location of the hole at any depth. They do an excellent job of this. Else, relief wells couldn't do a successful job of directional drilling to kill wild wells. Similarly, the inclinometers we use tell us whether or not horizontal drift is within acceptable limits.

Neither of these classes of instruments is good enough to measure changes of hole angles over short intervals. And, we must be able to measure these changes in angle precisely sometimes in order to determine if the hole is acceptable from the standpoint of being safe to drill and produce. Fortunately, several companies are now working either on improving the precision of present surveying instruments or in developing instruments especially adapted for dog-leg measurement. It's probable that one or more of these instruments will be on the market soon.

Reference

1. Lubinski, "Maximum Permissible Dog Legs in Rotary Bore Holes": Paper 1543-G, presented at 1960 fall meeting of Society of Petroleum Engineers of AIME.



HERE'S THE NEW TOOL in place for grinding a bevel on the squared-up end of cement-lined pipe. The grinder is driven by an air motor, so that the unit is portable, and can be used where electricity is not available. This tool can also be used on high-alloy pipe that cannot be cut or beveled with an acetylene torch.

HOW THE PIPE LOOKS after being squared up and beveled. Note that the cement lining is still intact, and flush with the pipe end.

New tool bevels cement-lined pipe

Pneumatic motor provides the muscle and high speed needed

BY W. B. BLEAKLEY
Production Editor

CEMENT-LINED PIPE, useful in fighting corrosion, has been a headache for the welder or the field man trying to maintain an unbroken lining in a water-injection or disposal system.

The big problems are these: (1) Cement-lined pipe is hard to cut, and cutting off a pipe joint with an acetylene torch usually means a rough end. (2) Repairing the lining after a torch cutoff or bevel operation takes a lot of time and is not practical for large-scale operations. (3) If the cement lining is not square with the cutoff end of the pipe, the welded joint will not have a completely protective film, and corrosion can get a foothold.

The solution. Phillips Petroleum Co. has come up with a solution to these problems. They have found a way to cut, bevel, and weld cement-lined pipe and still have continuous protection from salt water or other corrosive fluids.

In its pipe yard near Shidler, Okla., Phillips' material dispatcher, A. R. McKnight, is directing work on lined pipe, either new or salvaged, in diameters up to 7 in.

Pipe is fed into a cutoff machine that puts a square end on the pipe. This machine uses an abrasive cutoff wheel driven by an electric motor. The abrasive material in the wheel was chosen after a long period of experimentation. The wheel had to be able to cut through both steel and the cement lining with a minimum of chipping of the cement.

After cutoff, the pipe end is true, and the lining is flush with the steel surface.

New bevel tool. The rest of the operation, preparing the pipe for welding, is accomplished by a new tool developed specially for this application.

Conventional beveling is done by acetylene torch, but this method can't be used where there is a cement lining. Instead, an abrasive grinder has been made an integral part of a tool developed by the H & M Pipe Beveling Co., Tulsa.

This tool is lined up on the outside surface of the pipe, the grinder is put in rotation, and the grinder assembly is rotated around the pipe, putting the required bevel on the pipe end.

Heart of the new tool is the pneumatic motor used to drive the grinding wheel. This type of motor was chosen because of the need for high speed and lots of power. An electric motor with enough power to

drive the grinder would be too heavy for convenient field handling. By using a portable air compressor, the beveling machine can easily be used in the field, away from a source of electricity.

Welding. With the bevel in place the pipe is ready to be installed as part of the water system.

The cement lining on the prepared end of the pipe is coated with a special compound and two joints of pipe are brought together. Welding is done by making a nonpenetrating first pass, or stringer bead, so that the welding arc will not come in contact with the cement lining. The filler pass is made with normal welding currents. Every precaution must be taken to maintain an unbroken lining on the inside of the pipe.

The water-flood system at Burbank operates at pressures less than 500 psi. according to S. I. Betzer, Phillips superintendent, and the light welding process is satisfactory for this service.

Big savings. With this new technique, Phillips is able to salvage much cement-lined pipe that would otherwise have to be used in some noncorrosive application. Salvaged pipe is first inspected electronically to determine the wall thickness. Then some joints are hydrostatically tested. All this can be done with the lining in place and before the pipe is cleaned. If a joint is found to be useless, the cost of the cleaning operation has been saved.

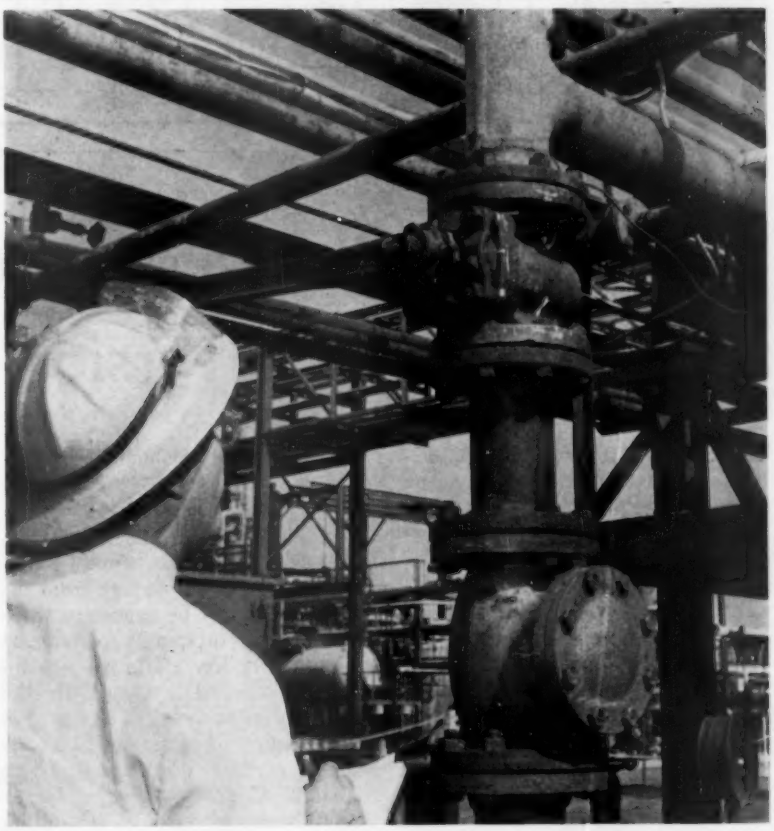
When the pipe has passed these preliminary inspections, it is then cleaned and run through the reconditioning process described here, and returned to service.

Other applications. The H & M beveling tool currently being used by Phillips will handle pipe sizes up to 8-in. (8⅝-in. o.d.). But there is no practical limit to the size that can be handled in the future. The same principle of operation can be applied to larger models.

H & M is currently building a cutoff tool using an air motor and abrasive wheel that can be used to square up the pipe ends before beveling.

The beveling tool has other applications besides its use on cement-lined pipe. High-alloy steel pipe, especially stainless steel, cannot be cut and beveled with conventional acetylene-torch methods. Use of the torch requires that the material being cut be oxidized, and high-alloy steels are made to resist oxidation. Preparing the ends of stainless pipe for welding usually means a trip to the shop where the pipe can be machined in a lathe.

With a portable cutoff tool and a portable grinder for beveling, pipe can now be prepared on the site in less time than it would take to get the pipe to the shop and back, to say nothing of the machining time. This could be a big help around refineries and chemical plants where stainless-steel lines are commonplace.



Plastic-coated values stand the gaff

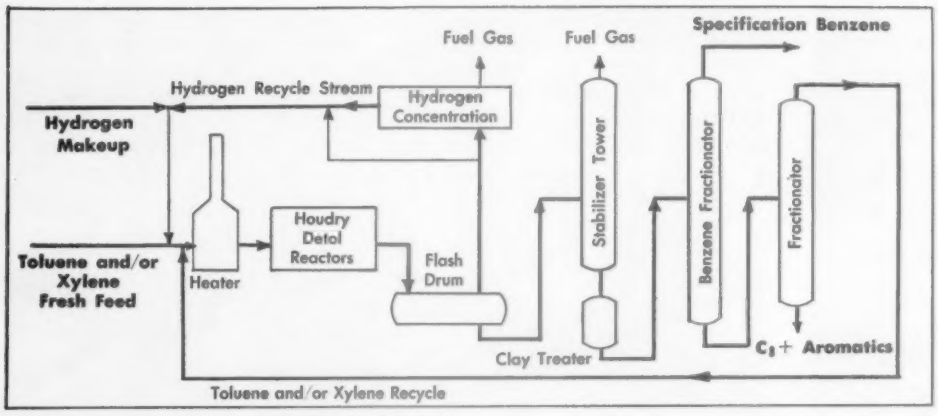
PLASTIC-COATED valves have been used in some of the process and acid-restoring units at Esso Standard's Bayway refinery in Linden, N. J., for over 2 years. Of the first ones installed, many are still in very serviceable condition. The stainless-steel valves which they replaced cost more than twice as much originally and could be expected to give no more than 1½ years of service.

The valves are ordinary steel Rockwell-Nordstrom lubricated plug valves coated with Penton, a chlorinated polyether made by Hercules Powder Co. They were successfully used to handle these fluids:

1. 45% sulfuric acid at 110° F.
2. 45-78% sulfuric acid for blending at 130°-140° F. temperature.
3. Spent butane with 65% mechanically entrained sulfuric acid.
4. Ethane with mechanically entrained traces of hydrochloric acid.
5. 43-35% spent sulfuric acid.

There are now approximately 3,000 of these plastic-coated valves in operation in a wide range of process plants throughout the industry. Of all such valves sent out, about 1% have been returned because of some sort of failure; the rest lived up fully to expectations.

Most of the failures resulted from physical damage to the coating caused by either abrasive material in line fluid, use of the valve for throttling, or a combination of both.



HOUDRY'S "DETOL" flowsheet for benzene production promises close to theoretical yields.

New Crown Central benzene unit will have high conversion efficiency

CONSTRUCTION of a new 17-million-gallon per year benzene plant has been started by Crown Central Petroleum Corp. at its Houston refinery.

Scheduled for completion at mid-year, the plant will be the first application of a new fixed-bed catalyst dealkylation process developed by Houdry Process Corp. Labeled "Detol," the highly selective process produces close to theoretical yields of benzene from toluene, xylene, and other alkyl benzene feed stocks.

Process highlights. According to process information from Houdry, dealkylation is carried out as follows:

The charge, together with a hydrogen-containing gaseous stream, is heated to reaction temperatures and passed over a dealkylation catalyst (see flow chart). The reactor effluent is cooled by heat exchange, then the benzene and unconverted alkyl benzenes are condensed and transferred to a high-pressure flash drum.

Liquid from the drum is stabilized, to remove materials lighter than benzene, and pumped to a fractionator from which specification benzene is removed as an overhead stream. The bottoms are further distilled to separate unconverted alkyl benzenes, which are then recycled through the fixed-bed catalytic reactors with the fresh feed.

BY D. H. STORMONT
Refining Editor

Hydrogen concentration of a portion of the recycle vapors from the flash drum may be necessary when the quantity or quality of makeup hydrogen is low. This step maintains a desired hydrogen partial pressure in the system. However, it also assures a makeup hydrogen stream of 65% or better hydrogen content. Concentration may be accomplished by use of molecular sieve, cryogenic differential condensation, or other economically acceptable processes.

Operating conditions for accomplishing hydrodealkylation in the reactors include temperatures in the range of 1,000°-1,200° F. and pressure of 500 to 1,500 psig.

When toluene is used as charge stock, benzene in the reactor effluents amounts to a yield of 96.5 mole % of the charge. On a volume basis, approximately an 80% yield is accomplished out of the 83.7% theoretically possible. The amount of benzene actually recovered, however, is dependent upon the type and efficiency of the recovery equipment installed.

Based on pilot-plant data, following is a typical yield balance for a unit charging 1,000 bbl. daily of nitration-grade toluene:

Charge:	
Toluene, bbl./stream day	1,000
Reformer offgas, M.M.s.c.f.d.	2.97 (82% H_2)
Products:	
Benzene, bbl./stream day	800
C_8+ aromatic reject (primarily biphenyl), bbl./stream day	15.8
Fuel gas (37.9% H_2), M.M.s.c.f.d.	2.95

The benzene produced will have a freeze point of 5.4° C. or better. Nonaromatics and organic sulfur compounds, if present in the feed, are converted to light hydrocarbons and hydrogen sulfide.

Plant investments are influenced by variations of capacity, quality of the hydrogen stream, and other factors. Utilities required per gallon of fresh feed will be about as follows, according to Houdry:

Steam, lb.	11.3
Electric power, kw.-hr.	0.207
Cooling water at 30° F. temp. differential, gal.	50
Fuel, net prod., M.M. B.t.u.	0.0217

Estimated operating costs for a plant on the Gulf Coast, such as that of Crown Central, are approximately 1.63 cents per gallon of charge. These include direct charges for labor, supervision, operating supplies and maintenance; utilities; catalyst; and chemicals. Capital investment and royalty charges will add about 2.8 cents per gallon to these costs.

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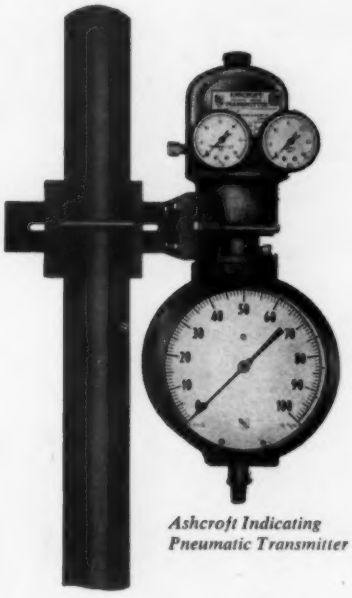

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How and why of torque factors (continued)

BY JOSEPH ZABA

USE OF TORQUE FACTORS in analyzing the performance of a beam pumping installation or sizing a new one can be best shown by a brief step-by-step example. This is summarized from previous work by D. O. Johnson,[1] and from the proposed API Recommended Practice for Calculation and Application of Torque Factors mentioned in Part 34 of the series.

The discussion covers only the crank-balanced units. Consideration of beam balance is quite complex and is not justified because of rather infrequent use of beam balance in modern pumping units.

Existing installation. Assume that a representative dynamometer card has been obtained, including the weighed counterbalance effect, at the polished rod. The procedure is as follows:

1. The dynamometer card is divided so that the loads may be found for each of the 15° positions of the crank corresponding to polished-rod positions as indicated by manufacturer's data. This is done by dividing the base line into 10 equal parts using a selected scale on the appropriate diagonal line, Fig. 45.

2. Assume that the load is to be determined for the crank angle of 75°. Manufacturer's data show that for this crank angle, and for the stroke to be used, the polished-rod position is 0.397 (fraction of the stroke above the lowermost position of the rods). From point 0.397 on the diagonal line a vertical line is projected to the upper portion of the dynamometer card. The indicated load multiplied by the dynamometer constant gives the well load at the 75° crank position.

3. The indicated well load, less unit offbalance (obtained from manufacturer's data) represents the net well load. The net well load multiplied by the torque factor (for 75° crank position and the stroke to be used, obtained from manufacturer's data), represents the torque on the reducer due to the net well load.

4. API Standard 11-E provides a form on which the manufacturer reports the maximum moment of rotary counterbalance about the crankshaft for different combinations of weights available with the unit. The maximum moment equals total weight times distance from center of crank rotation to the center of gravity of weights, with crank at the 90° position. Since the moment is to be determined for 75° crank angle the maximum moment must be multiplied by sine 75°.

5. Net torque on reducer for 75° crank position equals the torque due to the net well load less the moment due to counterbalance weights, both at the crank position in question.

6. By repeating the procedure for each of the 15° positions of the crank, the torque curves, Fig. 43, Part 34, can be constructed. Appropriate changes can then be made in counterbalance, if needed, to equalize the torques on the up and down portions of the stroke.

7. If manufacturer's data for the maximum moment are not available, this moment can be determined from the dynamometer card. The counterbalance line on the card represents the maximum counterbalance effect at the polished rod. This figure less the unit offbalance multiplied by the torque factor for the 90° crank position gives the maximum counterbalance moment. It should be noted that the maximum moment, if available, divided by the torque factor for 90° crank angle plus unit offbalance equals maximum counterbalance effect at the polished rod. Thus, the manufacturer's weight data can be checked if the dynamometer card is available.

New installations. On new installations no dynamometer cards are available. Then the procedure is:

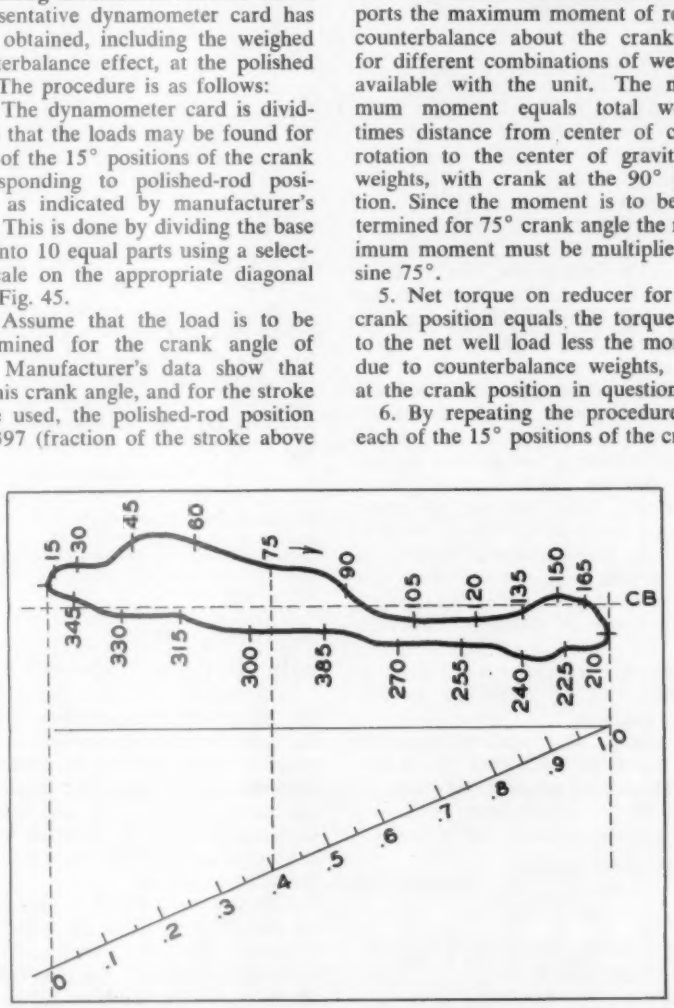
1. The maximum and minimum polished-rod loads are calculated with the available formulas (Part 7). Counterbalance effect needed at the polished rod is taken as the average of calculated loads (Part 8). Approximate torque is calculated as the product of unbalanced load (maximum load less the counterbalance effect) times half the stroke (Part 9). Commercially available unit of the next higher peak torque rating, with appropriate structural rating and desired strokes is selected.

2. The highest possible torque on the upstroke is calculated and from manufacturer's data peak torque factor for the stroke to be used is selected. Assume that this factor occurs at 75° crank position. The torque due to the net well load then equals the torque factor times the difference between the peak polished-rod load and the unit's offbalance (from manufacturer's data).

3. The calculated counterbalance effect needed at the polished rod less unit's offbalance multiplied by the torque factor for 90° crank position gives the maximum counterbalance moment needed at the reducer.

4. For the 75° crank position, counterbalance moment equals maximum moment times sine 75°.

5. Net torque then equals torque



DYNAMOMETER CARD divided according to crank angle from manufacturer's polished-rod position data. Fig. 45.

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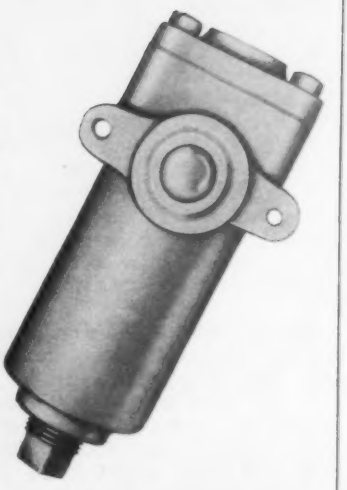

Amot Model 2400 Indicating Relay tells which engine hazard caused shut-down, (whether low oil pressure, high water temperature or what).
Uses air or gas pressure to function. One Relay used for each safety component in system.

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due to net well load less torque due to balance moment, both at 75° crank position.

6. In one of the approaches to finding downstroke torque it is assumed that minimum load occurs at around 180° from the maximum load. This is reasonable and is supported by analysis of a large number of dynamometer cards. Torque due to net well load would then equal calculated minimum well load less unit's offbalance times the torque factor for 255° crank position (from manufacturer's data). The torque due to counterbalance would equal maximum counterbalance moment already calculated, times sine 255°. Net torque equals the difference between the two torques.

7. For desirable torque conditions torque throughout the stroke would equal the average of up and downstroke torques. Appropriate changes in counterbalance weights could be changed to approximate such a torque. Check would then be made whether or not this torque is below the rating of the selected unit.

In these calculations it has been assumed that peak load occurs at the crank position corresponding to the peak torque factor. This is a justified assumption. In commercially available units the peak torque factors occur usually between 60° and 90° positions of the crank.

Admittedly this method is not exactly accurate because it is based on certain assumptions. For instance, loads are calculated by formulas which are only an approximation. Nevertheless, the method does represent a more realistic approach to the problem than the approximate method of claculating the torque because it takes into consideration the effects of, (1) transfer of well load to the reducer through the levers and pivotal points of a given unit and (2) phase angle of the counterbalance weights. The latter is of importance because at the time of peak net well load the balance weights are not acting through the lever arm of maximum effectiveness.

Difference between the two approaches may be illustrated by following example.

1. Assume that peak polished-rod load has been calculated at 16,800 lb. Minimum polished-rod load is 8,800 lb. Counterbalance effect needed at the polished rod is then

$$\frac{16{,}800 + 8{,}800}{2} = 12{,}800 \text{ lb.}$$

A 64-in. stroke will be used. Approximate torque then is

$$(16{,}800 - 12{,}800) \frac{64}{2} = 128{,}000 \text{ in.-lb.}$$

An API 160 unit has been selected.

2. Manufacturer's data on the selected API 160 unit are: Peak torque factor is 34.38. It occurs at 75° crank position. The torque factor for 90° crank position is 32.76. The torque factor during downstroke for crank position is 180° from peak torque factor position (75° + 180° = 255°) is −28.35. Maximum available counterbalance moment is 480,200 in-lb., and the unit's offbalance is 650 lb.

3. For upstroke the torque at 75° due to the net well load is (16,800 − 650) × 38.38 = 555,200 in.-lb. Maximum counterbalance moment needed is (12,800 − 650) × 32.76 = 398,000 in.-lb. (Check reveals that the selected unit offers the counterbalance moment needed.) At 75° crank position the counterbalance moment equals 398,000 × sin 75° = 384,400 in.-lb. The net torque equals 555,200 − 384,400 = 170,800 in.-lb.

4. For downstroke the torque due to net well load equals (8,800 − 650) × (−28.35) = −231,000 in.-lb. The counterbalance moment at 255° is (398,000 × sin 255°) = −384,400 in.-lb. The net torque is −231,000 − (−384,400) = 153,400 in.-lb.

5. Adjustment would be made in the counterbalance to equalize the torques on the up and downstrokes. The corrected torque would then be

$$\frac{170{,}800 + 153{,}400}{2} = 162{,}100 \text{ in.-lb.}$$

Torque of 128,000 in.-lb. reached by the approximate method was within the API 160 capacity. Torque-factor analysis suggests that unit could be slightly overloaded under given conditions. Overloads could be worse or better for units of different geometry.

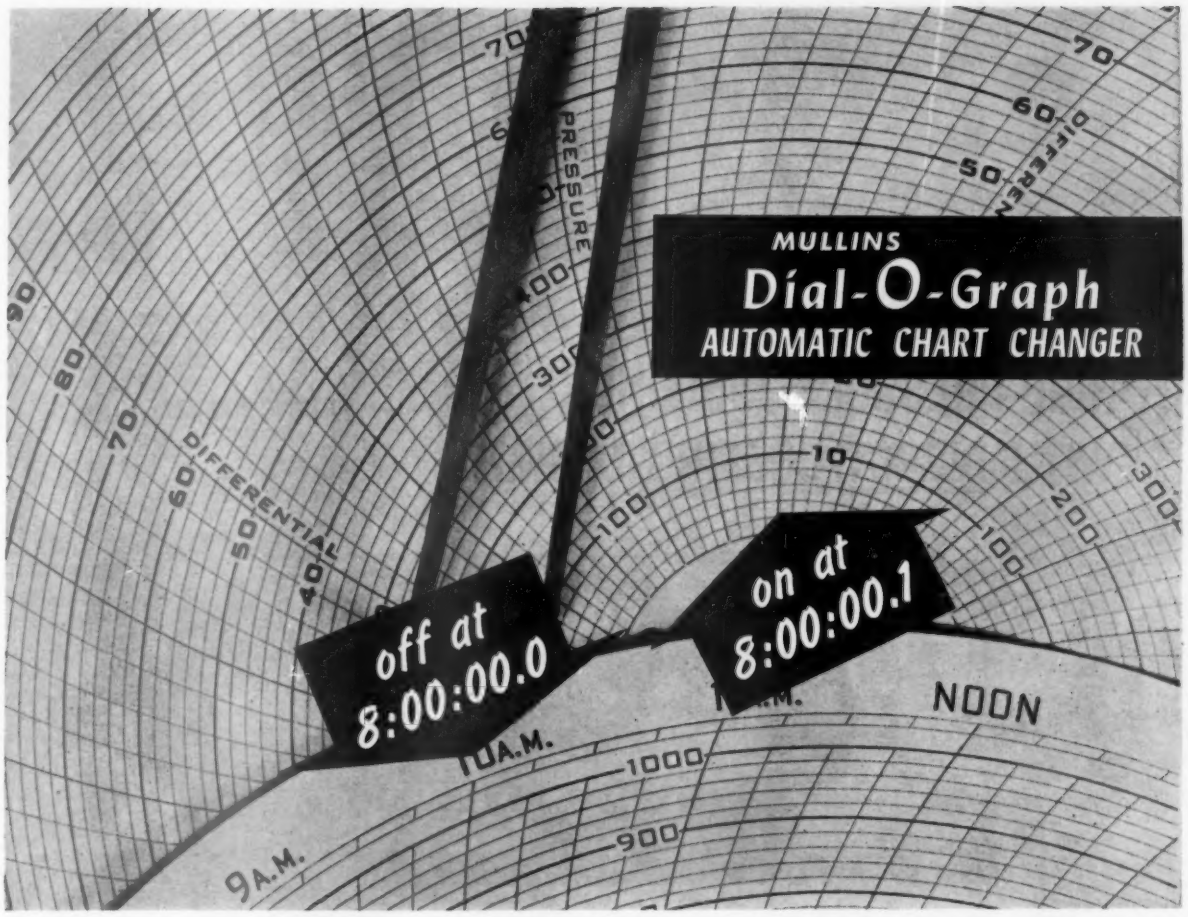
Reference

1. D. O. Johnson, "The Importance of Torque Factors in the Application and Operation of Pumping Units": Paper presented at the meeting of the Mid-Continent District API Division of Production, Oklahoma City, April 1958.

Antismog device sole UOP development

Universal Oil Products, Des Plaines, Ill., recently filed application with the State of California for testing its Purzaust catalytic muffler, in connection with state requirements for its possible use in California. This was the first such application in response to an invitation to 140 firms to submit devices for testing.

The Journal carried a photograph of the UOP muffler on page 115, February 20, 1961, issue. We inadvertently credited the development of this catalytic muffler to another firm, along with UOP. Actually, the device is a 100% UOP development.



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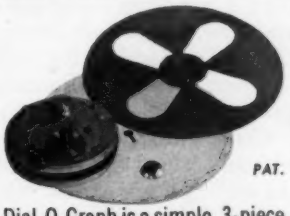
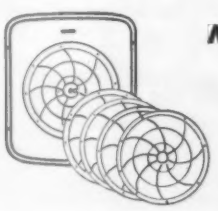


Dial-O-Graph is a simple, 3-piece attachment—Dial, Chart Plate, and Chart Drive (Mac-Nick)—that fits all recorders. Charts slotted only in center margin . . . same pattern for all instruments, all change times. (Not shown is transparent guide plate and metal chart catcher for storage of completed charts.)



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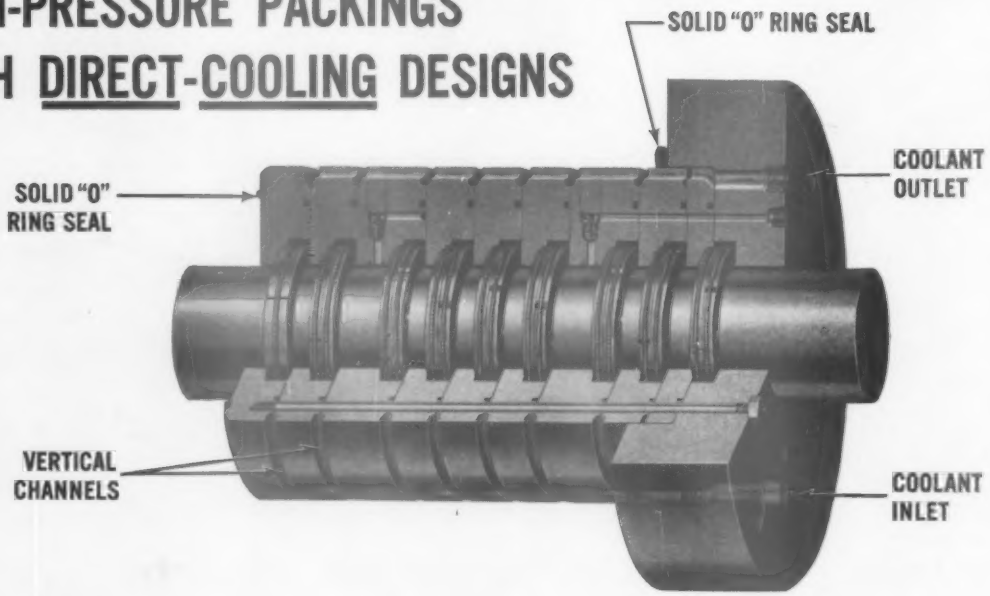
ENGINEERING

NEWS YOU CAN USE ABOUT ENGINE AND COMPRESSOR PERFORMANCE

COOK TAKES HEAT OFF HIGH-PRESSURE PACKINGS WITH DIRECT-COOLING DESIGNS



Here is a packing that keeps cool *even at pressures up to 50,000 pounds per square inch.* It's one of Cook's new packings for high-pressure applications —typical of recent advancements in direct-cooling packing design.

Connections for the coolant are handled easily without arranging separate inlets or outlets through the stuffing box. Coolant enters a trunk line at the bottom of the packing, then completely encircles the case through a series of multiple vertical channels. Heat from the high-pressure packing is carried off by the coolant through the outlet trunk line at the top of the packing.

But direct cooling is not limited to new designs. Cook's creative design engineering provides almost unlimited possibilities for direct cooling, even on existing packings.

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BY W. L. NELSON, Technical Editor and Petroleum Consultant

Questions on TECHNOLOGY

How much process steam for vacuum flashing

In your answer of June 6, 1960, you were reluctant in stating the actual amounts of process steam required in vacuum flashing. Can you give us some ranges for the amount of steam? J. W. H.

As indicated in the answer entitled "How Much Steam for Vacuum Distillation," such wide variations in operating conditions are encountered that the statement of representative process steam requirements becomes utterly bewildering. Nevertheless, the table shown here is an effort to bracket the amount of steam required as a function of the major variables, namely boiling range of the material, and the amount vaporized. In addition, it was necessary to select pressures. This was done generally by consideration of the factors that lead to most economical operation, as outlined on this page, August 4, 1958, p. 107 (Optimum Pressure for Vacuum-Plant Operation). Water temperature is the most important factor but it was simply considered as being adequately low in computing the table. However, note that most operators would prefer to avoid the use of process steam altogether if it be possible. Thus they tend to operate at somewhat lower pressures than indicated in the table here and to use little or no steam. Also recall that jet steam is needed for actuation of the vacuum jets, as well as the process steam shown here.

APPROXIMATE AMOUNT OF PROCESS STEAM REQUIRED FOR VACUUM FLASHING OF CONVENTIONAL STRAIGHTRUN RESIDUES

Percentage vaporized	Lb. steam per bbl. and vaporizer pressures* for mid-b.p. materials— 850° F.		800° F.		750° F.		700° F.	
	mm.	Lb.	mm.	Lb.	mm.	Lb.	mm.	Lb.
20	760	2.0	...	...	...	...	...	...
30	550	5.8	760	3.0	...	...	...	...
40	300	7.8	500	8.5	760	5.8	760	0.2
50	130	9.2	300	9.8	550	10.3	760	2.5
60	70	10.2	150	11.1	340	12.0	700	13.0
70	20	12.0	90	12.5	230	13.5	450	14.5
80	20	50.0	25	14.0	90	15.0	270	16.0
85	...	...	20	55.0	30	17.0	95	18.0

*The barometric condenser must operate at 4-9 mm. lower pressure.

Tabulated values of Nelson Construction Index

We would like to obtain monthly historical data (numbers) for the Nelson Refinery Construction Cost Index. T.H.V.

Tabulated values of the components used in the index through the year 1956 were published in the November 18, 1957 issue of this page (OGJ, p. 245). Shown here are the tabulated values for the years 1957, 1958, 1959, and part of 1960.

	Materials Component	Labor Component	Misc. Equipment*	Nelson Index		Materials Component	Labor Component	Misc. Equipment*	Nelson Index
January 1957	199.0	203.1	188.7	201.5	January 1959	207.5	226.2	195.5	218.7
February	199.0	203.5	189.1	201.7	February	207.9	226.2	195.7	219.1
March	199.1	203.6	189.1	201.8	March	207.6	226.6	195.8	219.0
April	198.9	204.0	192.0	202.0	April	207.0	226.6	195.8	218.8
May	199.8	206.1	192.0	203.6	May	206.7	228.7	195.9	219.9
June	201.4	208.1	192.1	205.4	June	207.2	230.2	196.3	221.0
July	204.9	209.7	192.3	207.8	July	207.8	233.9	196.9	223.5
August	205.4	212.4	192.1	209.6	August	207.8	235.2	196.8	224.2
September	204.9	212.5	192.8	209.5	September	208.1	235.8	196.8	224.7
October	203.4	213.1	192.9	209.2	October	208.4	236.2	196.1	225.1
November	202.6	213.2	195.2	208.9	November	209.2	236.6	197.4	225.6
December	203.4	214.2	195.5	209.9	December	208.9	236.6	198.7	225.5
1957 Year	201.9	208.6	192.1	205.9	1959 Year	207.8	231.6	196.1	222.1
January 1958	203.3	215.5	193.8	210.6	January 1960	208.9	237.3	198.6	226.0
February	203.9	215.6	193.9	210.9	February	208.6	237.4	199.5	225.9
March	203.2	216.1	193.0	210.9	March	207.8	237.6	199.5	225.7
April	202.5	216.6	193.2	211.0	April	207.9	239.0	199.8	226.6
May	202.5	217.9	193.3	211.7	May	208.0	239.7	200.4	227.0
June	202.0	220.4	190.6	213.0	June	207.7	242.6	200.5	228.6
July	202.2	222.6	190.6	214.4	July	207.4	244.3	200.5	229.5
August	205.2	223.0	191.4	215.9	August	207.7	†244.8	200.5	230.0
September	205.8	223.6	191.0	216.5	September	207.6	†245.2	200.5	230.2
October	205.8	224.1	191.2	216.8	October	207.2	†245.1	201.1	229.9
November	206.6	224.4	192.7	217.3	November	206.3	†245.1	199.2	229.6
December	206.5	224.7	193.2	217.4	December	206.4	†244.9	199.2	229.5
1958 Year	204.2	220.4	192.4	213.9	1960 Year	207.6	241.9	200.0	228.2

*Used only in computing the Materials Component. †Transition starting in September 1960 extending through May 1961 whereby the labor component will be changed from a 50:50 proportion of common and skilled labor to a proportion of 60% skilled labor.

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Lufkin Chrome Clad Anchor Tape (above, right) is available with easy-to-read markings in feet, tenths and hundredths, in genuine-leather, hand-stitched case. The handiest thing you can carry, on job after job.

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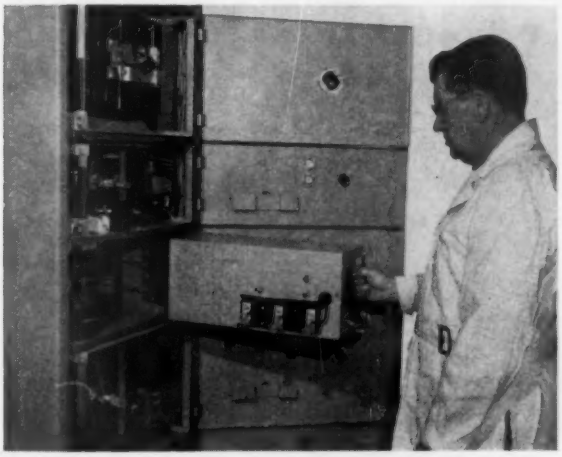
▶ ▶ ▶ New Equipment Section

This week's SHOWCASE features . . .

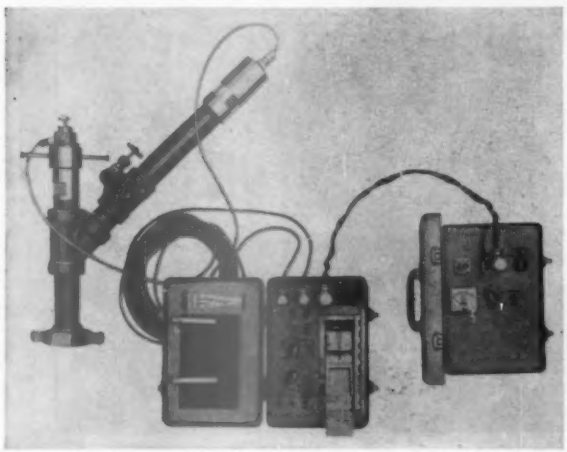


Electric-motor control center

. . . now available is designed specifically for use with automation systems. A number of features are offered. The swing-out starters and circuit breakers use permanent wiring for both load and control. Separable terminals eliminate the need to disconnect wiring when a unit is removed.

All wiring for load, control, and indication is brought to accessible master terminal blocks at the top or bottom. Tested before shipment, all interwiring is done at the factory. Each starter unit is equipped with fused control transformer, two extra interlocks, and a special microswitch. The microswitch provides an extra interlock to assure that the contactor is open and all the load removed before withdrawal of the unit.

The swingout removal design permits one man to replace a unit in less than a minute, the maker says. Source: **Nelson Electric Mfg. Co., P. O. Box 5385, Tulsa, Okla., U.S.A.**



Fluid level finder

. . . for finding the fluid level in oil wells now on the market is completely portable and requires only one man to operate it, the maker says. It reportedly is easily hand-carried to the vicinity of the well head and requires no special operator skill. A small rechargeable battery pack supplies power for 7 days of normal operation.

Operation is controlled from the instrument panel. A sound pulse is created at the wellhead by firing a blank cartridge in the annular space between casing and tubing. The sound pulse travels down the well and is reflected back to the wellhead by all obstructions. Each reflected pulse is amplified and recorded on a chart. Records are provided by an electrically heated writing arm.

The instrument is designed for well depths from 150 to 15,000 ft. and temperatures from 20° to 140° F. The maker says that, in most wells, the fluid level can be determined to within one tubing length (20 to 30 ft.). Source: **Servco, 2440 Cerritos Ave., Long Beach 6, Calif., U.S.A.**

Want more facts about equipment or copies of product literature described in this issue?

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Described in OIL AND GAS JOURNAL - Issue of **March 13, 1961**

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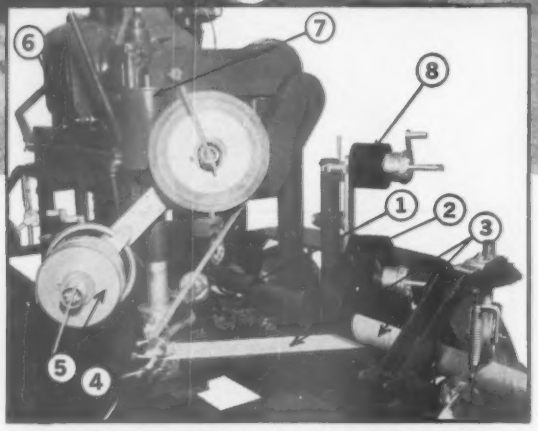
NEW TECHNIQUE ASSURES PERFECT ON-SITE COATING



Pipe (coming toward you) spins through machine . . . undergoes dynamic cleaning from twin-powered brush heads. Coating comes off brake-type tape drum. Outer wrapping runs through fast-gluing adhesive attachment.

1. Spinning pipe
2. Polyken tape coating
3. Outer wrap
4. Glue applicator
5. Stand-by outer wrap turret
6. Power brush heads
7. Glue tank
8. Stand-by tape turret

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Your protective coating results are only as good as the material you use and the way you put it on. And with Polyken tape . . . plus the special, new Polyken way of on-site application . . . you get a combination that really does a perfect job —*simply, speedily, economically.*

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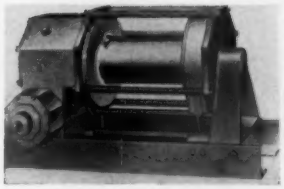

New type of power winch . . . developed which features a stationary shaft. Torque is transmitted direct from a gear spider to the drum by a multiple-splined collar in the gear-housing, instead of from the shaft to drum by use of keys as in conventional winches.

Hoisting capacity of the winch is 20,000 lb. Other features claimed for the winch include oil bath lubrication of the entire unit, easily adjusted multiple-plate automatic safety brake, accurate drum-clutch position indicator, and nickel-bronze alloy worm gear, with hardened and ground worm mounted on roller bearings. Gear ratio of the unit is 38 to 1. Source: **Koenig Iron Works, Inc., P. O. Box 7726, Houston 7, Tex., U.S.A.**

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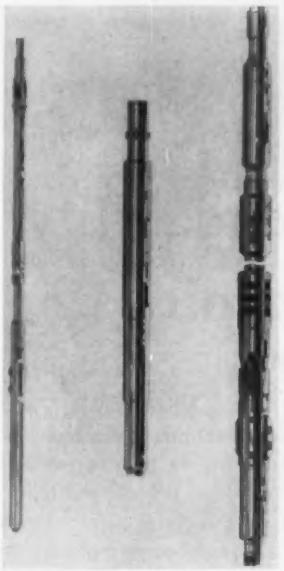
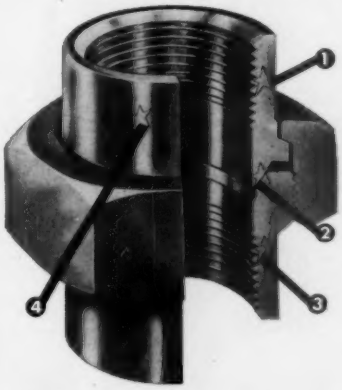


Test, completion tool . . . has been announced which was developed to eliminate rig down time for the operator or drilling contractor. According to the maker, eight operations inside casing down hole can be performed with the Full-bore test and completion tool without the necessity of making a round trip from each operation.

The operations include: formation and production testing, taking shut-

only
CATAWISSA
gives you all these features for your forged steel pipe union requirements



1. Uniform walls for even expansion and contraction under temperature changes. They follow the pipe!

2. Catawissa Ball-to-Angle Seats give you a "Perfect Seal" regardless of pipe alignment!

3. More than adequate wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

4. Round, straight barrels for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000 lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on machines with close inspection during and after production give you pipe unions second to none!

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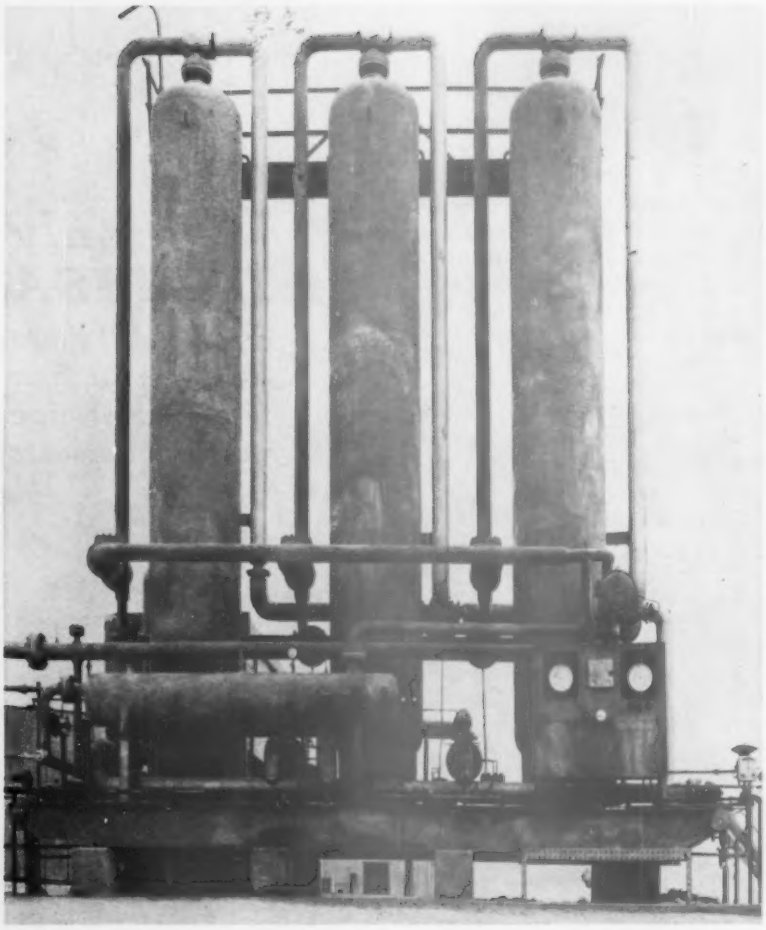

Hy-Sorb's Dependability Means More Earnings

This latest Maloney-Crawford Hy-Sorb three-tower recovery unit is designed for 23 MMSCF/D and 150 B/d of 14# stabilized R.V.P. product. This productivity can be accomplished with 18-minute cycles and M-C's special pre-cooling feature. One of the reasons for the high output is the Hy-Sorb's over-all dependability. A major factor in this dependability is the simplified control system which operates the entire plant from the panel shown at right in the photo. The Hy-Sorb can be operated automatically or manually, and a single selector switch controls all functions of the three towers. This unit is installed on Mustang Island, off the Texas coast, and is dimetcoated for weather protection. Another Texas operator reports that a Hy-Sorb, installed downstream from cold separation, has increased his stock tank liquids 22%. Let us give you more information on how the Hy-Sorb can increase your income from gas streams.

Maloney-Crawford

Box 659 **Tulsa**

in pressures, squeeze cementing, acidizing, fracturing, finding casing leaks, and reperforating with through-tubing perforating guns.

The maker says that, in formation or production testing, recovery of fluid samples and pressure charts is possible at any time. Components of the tool, as shown, include the center section (left) containing all test valve assemblies and the maker's pressure recorders, the outer case in which the center section seats (center), and the packer assembly containing a hydraulic hold down, packer rubbers, and anchor slips (right). Source: **Johnston Testers, Inc., P. O. Box 98, Houston, Tex., U.S.A.**

●

New sliding sleeve

. . . is designed to be collar size to allow for maximum clearance on multiple completions, yet provide a full-opening tubing inside diameter for bottom-hole work. The circulating ports are designed to give a flow area equal to that of the tubing in which the sleeve is run.

According to the maker, the Type A sleeve may be shifted with conventional tools. It is designed to receive a blanking plug which will permit the testing of the tubing string from either the bottom or top of the sleeve. Source: **Macco Oil Tool Co., Inc., P. O. Box 7288, Houston 8, Tex., U.S.A.**

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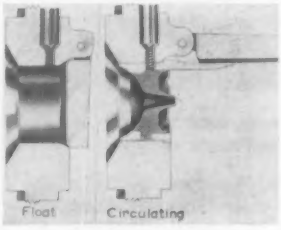

Two cementing valves

. . . just announced comprise an insert type of float valve and an insert type of circulating valve for primary cementing. The float valve is equipped with a flapper valve and designed for use when a conventional float collar is not considered necessary.

The circulating valve is designed

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To better supply oil field needs for precision work in flexible materials, OHIO RUBBER opens its newest, most modern plant in February, 1961, The Fort Smith ORCO plant—190,000 square feet, over 250 employees—utilizing the most advanced engineering and manufacturing concepts, will supply the petroleum industry with "Customeered", precision-molded rubber parts.

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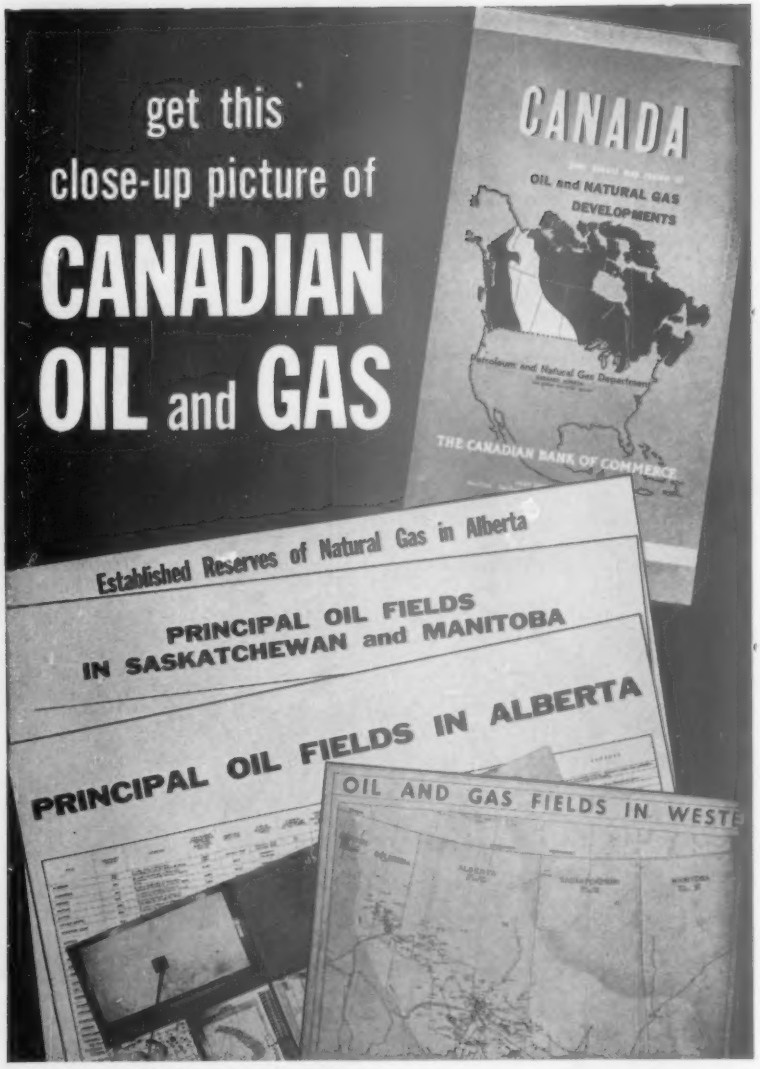

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New Equipment

so the flapper valve is held open by an aluminum retaining bar. The bar is integrally formed with the diaphragm insert ring and held in place by a retaining screw.

According to the maker, downward circulation may be established any time. The flapper valve is made operative by dropping a ball and shearing out the retaining bar by pump pressure.

Both cementing valves install in the casing coupling between the pin ends of the casing. They are made of drillable aluminum alloy. Source: **Larkin Packer Co., Waxahachie, Tex., U.S.A.**

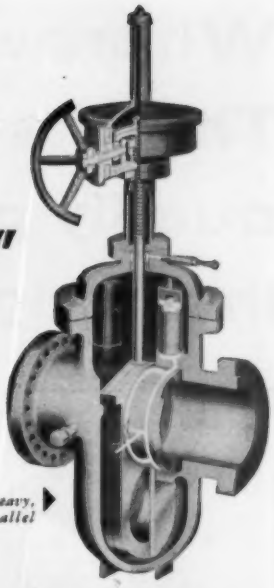
●

Fire, smoke detector

. . . is available which is claimed to be extremely sensitive. The device is designed so microscopic particles given off by a fire enter a sensitive sampling chamber in the detector where they interrupt the flow of a minute electrical current. When this happens, an alarm signal is flashed to a power unit where automatic controls can call a fire department, shut off fans, actuate extinguishing systems, or perform other desired functions.

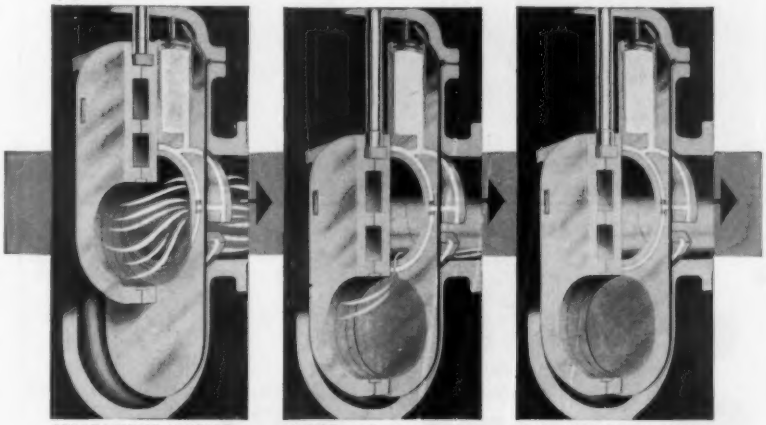
According to the maker, the Pyr-A-Larm detector meets all normal requirements of self-supervision and electrical safety. Any fault in the system such as a broken wire or the removal of a detector will immediately sound a trouble signal at the control unit. Besides the normal supervision, the unit may be equipped to run on batteries in event of power failure. Source: **Pyrotronics Div., Baker Industries, Inc., 10 Empire, Newark 12, N. J., U.S.A.**

NEW ADVANTAGES "GO ON THE LINE" with DARLING-McEVOY Conduit Valves



RIGHT: *Cutaway showing heavy, self-aligning gate and parallel seat assembly.*

BELOW: *diagrams of closure action on downstream side of gate.*



APPROACHING CLOSURE... *No loss of sealant.*

CLOSED... *Jumper in gate permits differential pressure to feed sealant into seat groove.*

AUTOMATICALLY SEALED ... *Pressures again in balance. Tightness established.*

Compare these features with *any* other pipe line gate valve:

1. EVERY CLOSURE LEAK-PROOF
2. NON-DIRECTIONAL FLOW
3. TWIN SEALANT RESERVOIRS
4. NEGLIGIBLE SERVICING
5. SMOOTH, FULL FLOW
6. REPACKING UNDER PRESSURE
7. EXCEPTIONAL PERFORMANCE AND LIFE

Darling-McEvoy conduit valves, made in 8″ and larger sizes, are fully field proved. Now operating continuously on various major lines. For complete information on the self-sealing feature and many other advantages of this unique valve, ask for Bulletin 5402.

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Williamsport 1, Pa.

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Wherever oil flows... There's a Dresser® quality piping product that's right for the job

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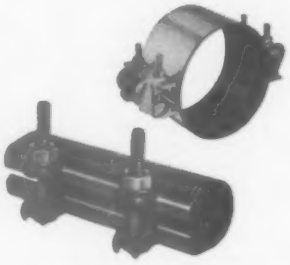
FOR PIPE REPAIRS



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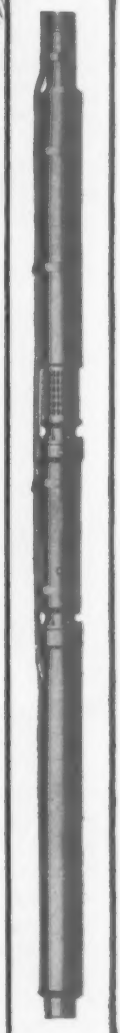

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- **A complete line to meet pumping requirements**

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Manufacturers of submergible motors and pumps for over 35 years — for oil, brine and water wells, gasoline and jet fuel

Valve

. . . with plastic bar stock body designed for applications involving highly corrosive fluids. The Design DP body comes in a single-port globe style in three sizes: ½, ¾, and 1 in.

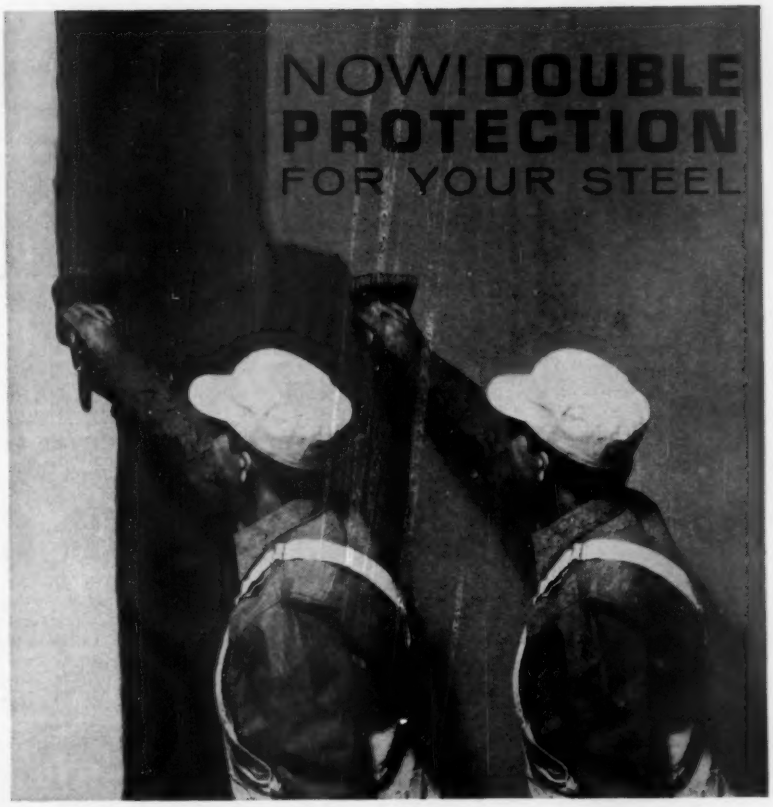
Material may be either Penton or Type 1 rigid polyvinyl chloride. Pressure ratings go up to 125 psi. Both body types are available with screwed end connections and with connections suited for mounting between pipeline flanges. The PVC body can also be obtained with socket ends for solvent welding.

The valve plug is a port-guided, percentage type, available in either plastic or metal. One to three flutes can be provided on the valve plug to obtain different capacities for the same orifice size. Actuators can be obtained to give normally closed or normally open operation. Source: **Fisher Governor Co., P. O. Box 307, Marshalltown, Iowa, U.S.A.**

●

Check plate

. . . for process plants separation and treating installations, and petrochemical plants comes in line sizes up to 24 in. for differential pressures up to 100 psi. According to the maker, the plate can be made to operate in virtually any gas or liquid stream without damage. The



CARBO ZINC 11* *as a primer—*

protection continues even after topcoats are penetrated

Carbo Zinc 11 is an inorganic zinc-filled coating which gives protection similar to galvanizing. It is used either as a lining, a one-coat maintenance system, or a primer with color topcoats.

You can topcoat Carbo Zinc 11 in color with any of these generic types: epoxy-ester, catalyzed epoxy, vinyl, Hypalon, chlorinated rubber. Choose the correct topcoat that meets your chemical or weathering exposure requirements—and upgrade your present protection.

Sacrificial properties of Carbo Zinc 11 prevent undercutting or subfilm corrosion if surface is penetrated. This exclusive characteristic protects and lengthens system life 2-3 times. You save money by reducing repainting cycles.

Application advantages: use spray, brush or roller—at temperatures from 0° F. to 150° F., at humidity to 95%. Water insoluble in 20 minutes. No curing solution or subsequent surface preparation required. 6101

*Patent applied for

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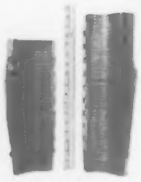
FITTINGS

WRITE FOR NEW FITTINGS BULLETIN P. O. BOX 1739, TULSA



KelCo's Standard and Long Dies Give More Pipe Contact

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Famous KelCo features make these air-operated casing slips a necessity for safe, efficient pipe running. Slips are raised and lowered by dual air cylinders. Protects casing, saves time, makes you money. For 4½" through 7" casing.

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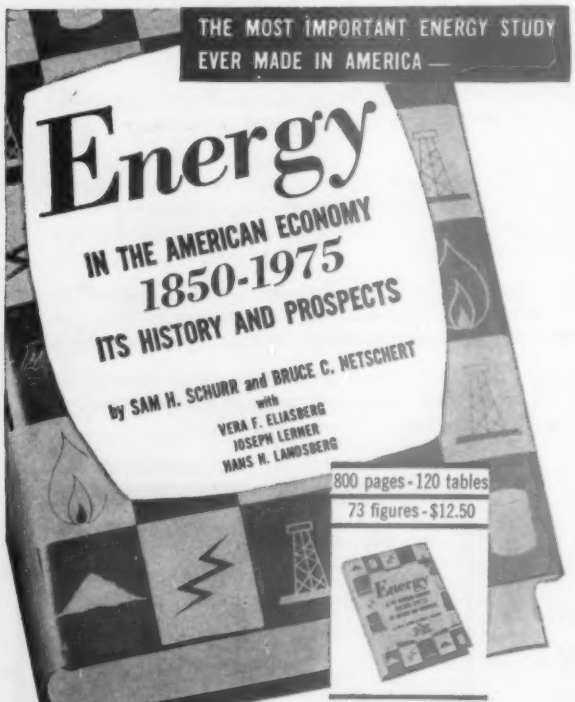

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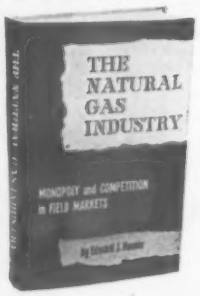

The Natural Gas Industry

Monopoly and Competition in Field Markets

BY EDWARD J. NEUNER

Is there a gas industry monopoly in field markets . . . or isn't there? Is it really necessary for prices to be regulated by the federal government?

Here is a detailed, impartial investigation of the most controversial public economic policy of our times . . . the requisite factual and analytical foundation upon which a rational decision could be made . . . for all who are concerned with the details of natural gas production and its regulation, control, and resulting price to customers.

THE OIL AND GAS JOURNAL
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technological breakthrough for measuring H_2O in H_2

The Beckman Hygrometer, equipped with the new hydrogen electrolytic cell, establishes new standards of accuracy for measurement of moisture in hydrogen streams. In the past, measurement of moisture in hydrogen has been marginal at best because of frequent catalytic reforming of H_2O within the cell, and subsequent remeasurement. ⌘ The new Beckman Hydrogen cell utilizes an element length where errors in efficiency and recombination are approximately equal and opposite, and hence cancel. Thus, you obtain readings of an accuracy heretofore unattainable. ⌘ If your problem is keeping hydrogen "dry" in process streams... in refining, catalytic reforming, and annealing, for example ...your nearest Beckman Sales Engineer can help you. Or write for application Data File 24-11-14.

Beckman
Scientific and Process Instruments Division
Beckman Instruments, Inc.
Fullerton, California

maker's standard check plates come in red brass or aluminum bronze. But other materials are obtainable. Source: **Tesco, Inc., 1403 E. 5th Court, Tulsa 20, Okla., U.S.A.**

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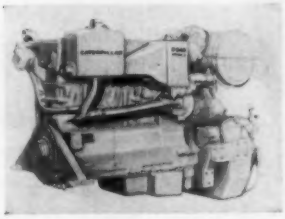


420-hp. diesel engine

. . . weighs only 9.95 lb. per hp. The D343 Series A engine has six cylinders, twin overhead camshaft, 5.4-in. bore, 6.5-in. stroke, and an 893-cu.-in. displacement. It is available turbocharged, or turbocharged and aftercooled. With turbocharging only, it is rated at 360 hp. With turbocharging and aftercooling, it is rated at 420 hp.

The engine features a four-stroke-cycle design. The precombustion chamber fuel system is designed to enable the engine to burn a variety of fuels from premium diesel fuel to furnace oil. Source: **Caterpillar Tractor Co., Engine Div., Peoria, Ill., U.S.A.**

●

New tool-joint compound

. . . serves as a protective coating and lubricant for drill-pipe threads for shallow and moderate depths. Additives are used to cause the coating to remain on the drill pipe after it is broken out and so prevent rust.

The maker reports that thorough field testing has determined that the product has excellent antigalling properties and high resistance to water penetration. The product comes in 2½-gal. cans containing 20 lb. Source: **Gulf Oil Corp., Dept. DM, Gulf Bldg., Houston 2, Tex., U.S.A.**

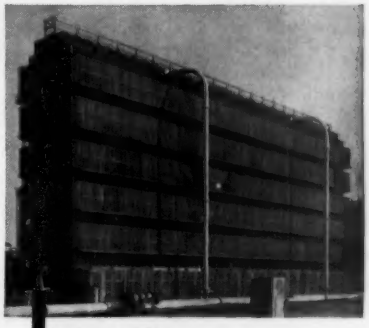
●

New communications system

. . . enables the maker's electronic computers to transmit and receive data over existing long-distance lines while simultaneously performing other data-processing tasks.

The data communications control units, Models H-880 and H-480,

NEW LIFE FOR OLD COOLING TOWERS



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- **Experience with all makes and models of cooling towers**
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For egg-shaped pipe. Insures even, accurate cuts of irregular pipe. Roller rides pipe surface . . . makes cutting easy, simple. Fits All H & M Machines.

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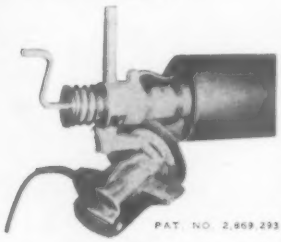
For intersectional cutting. Accurately cuts saddles, tees, els and other irregular shapes. Lightweight and extremely portable. Fits all H & M Machines.



BEVEL-LAND GRINDER
Smooths pipe cuts and accurately places the lands on bevels in a matter of seconds. Eliminates costly handwork.

H & M's complete line of pipe cutting and beveling machines can save you money. Write for catalog sheets and price lists, TODAY!

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COUPLINGS BY Wheeling

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Wheeling, West Virginia

West Coast Factory: Woodlake, California

are designed to transmit data over existing communications networks and are intended for use on either private leased lines or with toll service. Transmission is usually at the rate of 150 characters per second, the maker says. Source: **Minneapolis - Honeywell Regulator Co., Electronic Data Processing Div., Wayne and Windrim Aves., Philadelphia 44, Pa., U.S.A.**

•

Gamma-ray inspection systems

. . . are being marketed for precision measurements of thickness and density of such materials as pipes, steel plates, and laminations of metals; inspection and quality control of thickness and density, and measurement and control of fluid levels.

They are expected to prove particularly useful as automatic controls where adverse temperature, pressure, corrosive conditions, or remote locations, make other methods impractical. Source: **Radio Corp. of America, Industrial Controls Div., Building 15-1, Camden, N. J., U.S.A.**

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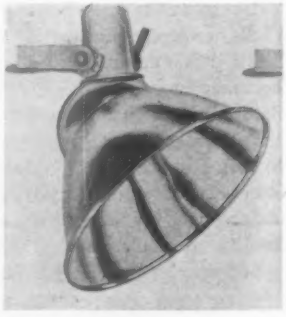

New floodlights

. . . feature an auxiliary inner floating reflector. The floodlights come in five beam spreads to meet a variety of applications. Tradenamed Econoflood, the lights have a one-piece weathertight aluminum hood. They can be relamped from the front or rear. No tools are required for rear maintenance. A variety of mounting accessories are available. These include base mounting, pole mounting, pipe mounting, and a verticle surface-mounting bracket. Source: **Appleton Electric Co., 1701 W. Wellington Ave., Chicago 13, Ill., U.S.A.**

SHOWCASE . . .

New Literature

Booklet details marine tractors

. . . called "Harbormaster," which are marine outboard and propulsion units in one complete package. The two-page literature piece gives features, specifications, installation data, and advantages. A comprehensive table gives specifications on 17 models from 40 to 500 hp. Source: **Murray & Tregurtha, Inc., 80 Hancock St., Quincy 71, Mass., U.S.A.**

Aluminum-grating

. . . folder, now available, lists engineering data including a table of safe loads and panel width in inches. Applications listed consist of: catwalks, floors, window guards, stair treads, along with other industrial uses. Source: **Grating Div., Rock-Well-Standard Corp., 4000 E. Seventh Ave., Gary, Ind., U.S.A.**

Liquid water treatment

. . . for users of internal-combustion engines with closed water systems, prevents rust, corrosion, and scale, as described in a new four-page bulletin. Described as the ideal water treatment for industrial plants and offshore drilling rigs, the product is said to be completely safe to man and machine. The four-page bulletin offers photos, instructions for use, advantages, and applications. Source: **Hafco, Inc., 7811 Carondelet, Clayton 5, Mo., U.S.A.**

Free thread loosener

. . . in a trial aerosol can, is now being offered for freeing tight, rusted, or seized parts. The lubricant—Easy Spray—is packaged in a 16-oz. container. It quickly penetrates rust and corrosion to free tight or rusted pins, linkage, hinges, nuts, bolts, valves, and other seized parts, the manufacturer claims. Source: **Whitmore Mfg. Co., Box 1620, Station C, Cleveland 4, Ohio, U.S.A.**

Sprayed-asbestos coatings

. . . for fireproofing, insulation, and acoustical control are introduced in an illustrated technical catalog, yours for the asking. Specification tables show light reflectance, fire-hazard classification, sound absorption, fire-retardant ratings, and coefficients of heat transmission. The four-page bulletin describes characteristics of soft and hard types of coating, and provides data on application, characteristics, and advantages. Source: **Emjay Maintenance Corp., Box 111, Rutherford, N. J., U.S.A.**

Electronic monitoring system

. . . which is said to monitor accurately any condition that can be represented by an electrical contact closure, is described in an eight-page booklet just issued. Typical applications include: circuit breakers, motor-driven valves, hazardous-atmosphere-sensing devices, communications equipment, pressure switches, temperature switches, level switches, over-or-under voltage or speed switches, flow switches, and transmission of binary-coded analog data. Source: **Lynch Communication Systems, Inc., 695 Bryant St., San Francisco, Calif., U.S.A.**

Nondestructive testing equipment

. . . is illustrated and described in new 12-page Bulletin 00-105 which highlights ultrasonic testing equipment, portable industrial X-ray, and magnetic-particle inspection equipment and supplies. Included are inspection principles, applications, principles of operation, and methods of inspection. Source: **Sperry Products Co., Danbury, Conn., U.S.A.**

Chromatograph

. . . Model 26-212 features high-speed analysis — typically in 1/20 to 1/50 the time previously required. Bulletin 26-212 gives full details of the chromatograph's performance with pneumatic, electronic, and computer systems. Source: **Analytical & Controls Div., Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif., U.S.A.**

Fire-pumps Bulletin 401

. . . shows cross-section drawings, typical installations, size and capacity charts, and detailed advantages of a vertical fire pump in six pages. Both oil and water-lubricated

Entering its tenth year of service to the industries that produce and distribute natural gas, Transco points with pride to the stability of markets it affords producers, and to the economies of transmission it affords customers. TRANSCO — the pipeline carrying natural gas to the markets where the most people are.

TRANSCO 10TH ANNIVERSARY

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types are detailed, complete with accessories to meet Factory Mutual and Underwriters' Laboratories requirements. Source: **Layne & Bowler, Inc., Box 6697, Hollywood Station, Memphis 8, Tenn., U.S.A.**

Free ton-mile calculator

. . . for drilling, now available, makes it easy to figure ton miles per round trip quickly. The calculator is 4¾ by 10½ in., with large, readable type. There are two slides and it will compute ton-miles for depths to 30,000 ft. using drill pipe up to diameters of 6⅝ in. A typical example is shown and step-by-step directions are included on the calculator slide rule. Source: **Macwhyte Wire Rope Co., 2900 Fourteenth Ave., Kenosha, Wis., U.S.A.**

Torsionally resilient couplings

. . . called "Steelflex," are outlined in new 24-page Bulletin 4100, available gratis by request. The revised literature gives additional coupling types, dimensions for larger sizes, and easier selection methods. It explains how the maker's new grid-groove coupling design protects connected machines against shock, vibration, and misalignment. Charts and tables contain up-to-date engineering data. Source: **Falk Corp., Box 492, Milwaukee 1, Wis., U.S.A.**

Threadless fittings

. . . that are said to provide fast assembly in such operations as tank-battery hookups, lead lines, salt-water-disposal lines, rig fuel and water lines, temporary and miscellaneous lines, and pipe repairs are detailed in a new bulletin. It explains that no threading, grooving, or special pipe preparation is necessary. The six-page bulletin features cutaway views of the fittings along with a sketch of a typical tank-battery hookup. Included are data on the fittings' size, length, and approximate weight. Source: **Continental-Emsco Co., Box 359, Dallas 21, Tex., U.S.A.**

Convert casing couplings

. . . to cement collars, as described in new Technical Bulletin 382. It tells how new insert valves can be made up in casing couplings as an economical substitute for conventional cement collars. The valves, available in either floating or fillup models, are recommended for primary cementing programs of moderate depths. Source: **Baker Oil Tools, Inc., Box 2274, Terminal Annex, Los Angeles 54, Calif., U.S.A.**

Flexible plastic pipeline

. . . which consists of an inner high-impact plastic pipe, reinforced against internal pressure by helically applied steel tapes which are protected against corrosion by an outer sheath, is detailed in an available eight-page bulletin. It includes a technical description of the flexible pipelines, design data, the range of pipes obtainable, a cutaway drawing showing couplings, and information on installation. Source: **British Insulated Callender's (Submarine Cables), Ltd., Trafford Park, Manchester 17, England.**

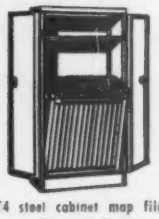
Fishing-tool catalog

. . . includes operational information, maintenance and spare-parts-catalog data, shipping weights, and price data on an entire line of fishing tools. Also listed in the 48-page catalog are representatives outside the United States. Source: **Wilson Supply International Div., Drawer 19, Houston 1, Tex., U.S.A.**

Oil-spillage boom

. . . for limiting pollution damage and accidental spillage losses, is outlined in a new eight-page pamphlet. The literature piece lists advantages, construction features, handling procedure, maintenance, and general information. Source: **William Warne & Co., Ltd., Barking, Essex, England.**

CONFIDENTIAL—DOORS LOCK!

MAP  FILE

The sturdy MT4 steel cabinet map file has 112 tilting tubes. Easy to file and find maps, tracings and blue prints to 60" lengths. Keeps valuable information dust proof and confidential. Popular everywhere in both field and home offices. Write for illustrated information.

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Patent No. 1610368, Other Patents Pending.
SCOTT-RICE CO., 610 S. Main, Tulsa 19, Okla.

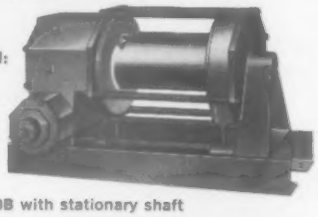
Koenig INTRODUCES A REVOLUTIONARY NEW TYPE OF HEAVY-DUTY POWER WINCH

FEATURING TORQUE TRANSMISSION DIRECT FROM GEAR SPIDER TO DRUM . . . NO KEYS TO SHEAR

20,000 pounds safe hoisting capacity

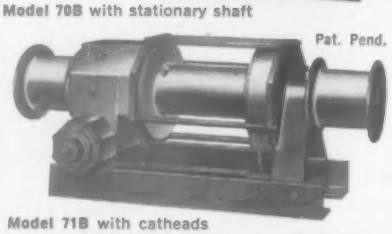
Outstanding features of the NEW KOENIG WINCH:

★ Drum torque load is NOT transmitted by drum shaft . . . no keys to shear . . . torque is transmitted direct from gear spider to drum by means of multiple-splined collar in gear housing.
★ Entire unit, including safety brake, is lubricated by the oil-bath principle, with a generous supply of oil to prevent overheating.
★ Engineered to use standard lubricants available throughout the world.
★ Multiple-plate automatic safety brake, running in oil with one-direction clutch, is easily adjusted or released.
★ Accurate drum clutch position indicator.
★ Gear ratio — 38:1.
★ Nickel-bronze alloy worm gear. Hardened and ground worm mounted on Timken roller bearings.



Model 70B with stationary shaft

Pat. Pend.



Model 71B with catheads

THIS ADVANCED-DESIGN KOENIG WINCH IS RECOMMENDED FOR OIL-FIELD EQUIPMENT, PUBLIC UTILITIES, HEAVY WRECKERS, CONSTRUCTION, AND OTHER HEAVY-DUTY JOBS.

Koenig winches have served the industry with dependable pull and hoisting power since 1934. Koenig also builds a complete line of utility and service bodies.

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Take the combination of Union wire rope *quality* and National Supply *service* and you can't find a smarter buy in the oil country.

Union Wire Rope specializes in high carbon wire rope. Union products are job-proved on the world's deepest wells under toughest operating conditions. Union specialists thoroughly understand oil country problems and make the products that serve you best.

National Supply stores carry complete stocks of Union wire rope products including *Tuffy* rotary lines, sand lines, cut rope and slings. Service is fast and dependable. And there are 115 of these stores located strategically to serve your needs. Like all the fine products available from National Supply, *Tuffy* wire rope products will give you longest service, greatest efficiency and safety.

No matter what your needs, from wire rope to complete drilling rigs, next time you buy, see National Supply.

See next pages for information on NEW B-275 ROTARY

New National Supply

rounds out complete line of rectangular design rotaries for drilling at any depth

The new B-275 rotary completes the full line of National Supply rectangular design rotary machines to meet every table opening requirement from 17½" to 27½". The full line is as modern as any major drilling equipment available today.

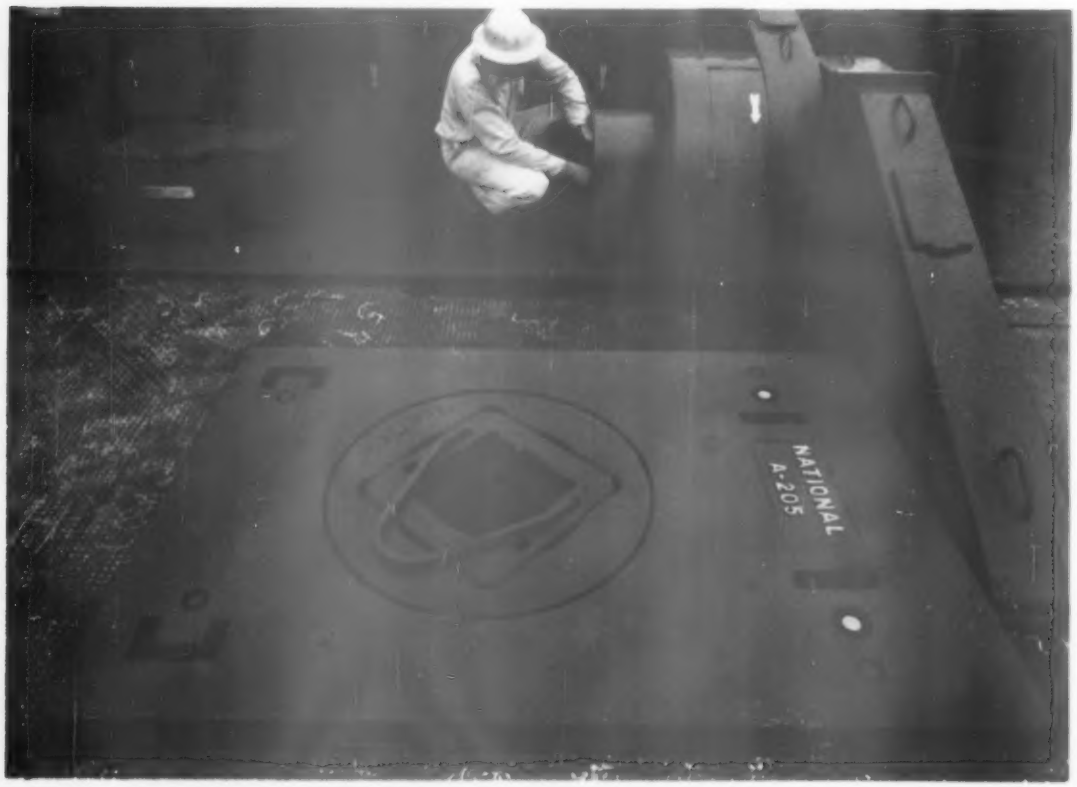
Here is the line-up of National rotaries, each capable of providing faster round trips and casing jobs:

SA-175 Designed for shallow to medium depth drilling. It has a 17½" table opening and 44" spacing. It is suitable for either portable rig hook-ups or standard mast and derrick installations.

LA-175 Same capacity and size rotary, except that the LA-175 has a 53¼" spacing from center of the table to the sprocket.

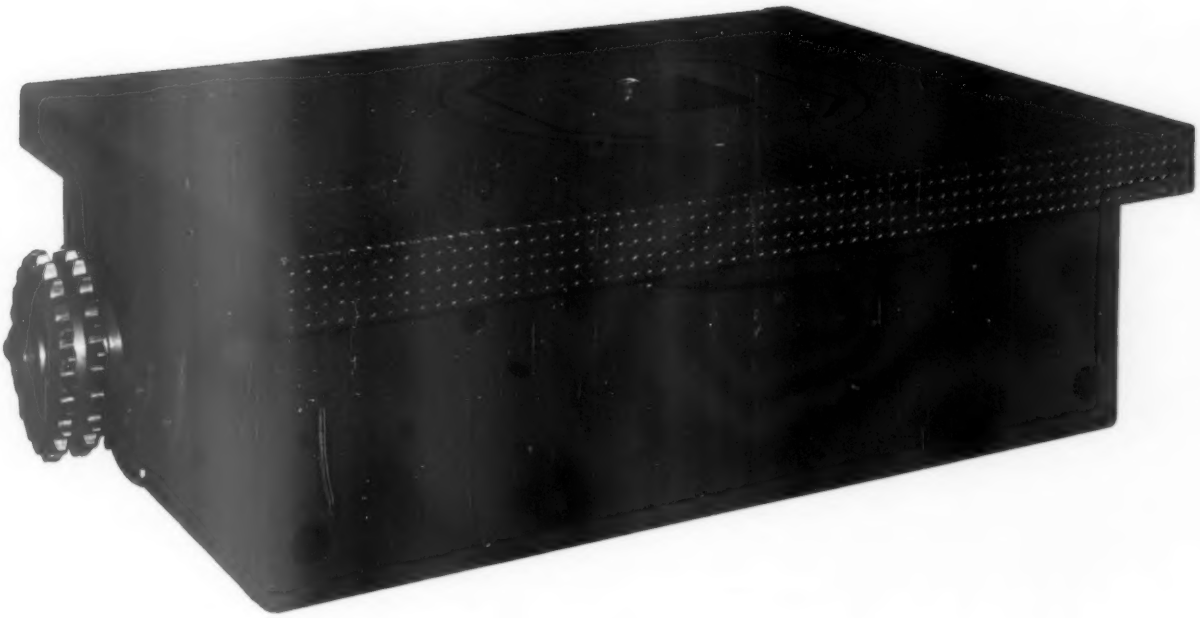
A-205 Designed for medium and deep drilling and all standard rig-ups. It has a 20½" table opening and a standard A.P.I. 53¼" spacing.

B-275 This new rotary is designed for deep drilling. It has a 27½" table opening, with a 450 ton static load rating.



This is a National A-205 rotary installed in a National 80-B rig. Modern design features of the new square table National rotaries make them easy to install and maintain.

B-275 Rotary



☆ 450 Ton Static Load Rating
☆ 27½" Table Opening
☆ Easy to Install, Operate and Maintain

Rectangular Housing and Cover. Rig flooring can be flush-fitted to the table top for clean, safe working areas. Cover is fabricated of extra-heavy non-skid plate.

Matched and Lapped Spiral Bevel Pinion and Gear. Pinions and gears are perfectly matched at the factory and lapped for smooth, quiet operation. They are made from quenched and tempered alloy steel. Pinion teeth are flame hardened.

Unitized Gear Table Assembly. Main and hold-down bearings are unitized with the gear table and gear. This permits complete bearing adjustment before installation of the table assembly in the housing. The assembly is dynamically balanced and mounted on precision ball bearings.

Cartridge Pinion Shaft Assembly. Pinion shaft and bearings are enclosed in a cylindrical housing that assures accurate and permanent alignment of the bearings. The assembly is positioned for fast, easy servicing.

Selective, Direct Table Locks. Two independently operated racheting lock pawls are arranged to engage the slots in the rims of the gear. Each pawl locks the gear table in a different direction. Engagement of both pawls locks the table in both directions. Lock pawls are grease lubricated.

Pinion, Gear and All Bearings Are Oil Lubricated. The pinion and gear, pinion shaft bearings, ball bearing and the upthrust ring are all cascade lubricated from a large central reservoir. Oil is added at one easily accessible location.

It will pay you to investigate the many advantages of the National rotaries.
Ask your National Supply representative for complete details, or write to
National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pa.

Steel

Steel's Symbol of
strength, long life,
and economy

NATIONAL
Roller Kelly Bushings

assure smooth, friction-free movement of the kelly

All National roller kelly bushings provide operational advantages for smooth feeding of the kelly through the bushing. And they afford accurate weight readings.

They feature large rollers mounted on tapered roller bearings for minimum friction. All rollers are mounted in a single plane, with a separate roller for each kelly face. The simple, rugged construction permits individual roller lubrication. Generous compartment openings around the rollers provide natural cleaning and flushing areas. This simplifies cleaning and reduces mud accumulation.

You'll find it pays to specify National roller kelly bushings next time you buy.

National Roller Kelly Bushings are easy to clean and lubricate.

Solid, two-piece National Master Bushings reduce wear in deep drilling.

Conventional Table Bushings will fit any size National rotary.

NATIONAL
Table Bushings

reduce bushing and table wear

Traditional National Supply quality is built into National table bushings, which are available in conventional master bushings and in solid, two-piece bushings.

The split, or conventional, table bushing will fit any size National rotary. All driving and driven faces are flame hardened for longer wear.

The solid two piece master bushings will fit the A-205 and the new B-275 National rotaries. Upon application, these bushings can be installed in older model tables now in the field. The design of the solid two piece master bushings reduces wear, drill pipe distortion or gouging generally encountered in deeper drilling.

See your National Supply representative for details of National roller kelly bushings and table bushings. Or write to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pennsylvania.

ARMCO National Supply Division

▶ ▶ ▶ Equipment Men Notes

Baird Mfg. names Jim Thomas

. . . to the newly created post of general manager of sales, in which position he will direct both export and domestic sales for the entire company. Prior to his appointment, Thomas was Baird's sales representative in Oklahoma and northern division sales manager. He previously was with Pacific Pumps, Inc., for 16 years, and has been active in production equipment and sales for 18 years.

Baird Mfg. Co., headquartered in Tulsa, has made oil production and well-servicing equipment for 35 years. Sales representatives and offices are maintained in principal oil-producing areas of the United States and Canada.

Baash-Ross names Ray Gorman

R. E. Gorman

. . . as Mid-Continent area sales manager with headquarters in Oklahoma City. The announcement was made at the Houston home office by R. A. Forsman, director of sales and service. Gorman previously was sales manager of the Dallas-Fort Worth district for Baash-Ross, a division of Joy Mfg. Co.

Forsman also announced the establishing of two new rental and service locations by the company. Ross Himmelreich will head up the establishment at Edmonton, Alta., and A. J. Heath is in charge of the new operation at Wooster, Ohio.

Zapata Off-Shore Co. acquires

. . . a stock position in National Tube Coating, Inc., the Beaumont firm which recently developed a process for plastic coating the interior of tubular goods used in drilling and completion of oil and gas wells to combat corrosion. Zapata, based in Houston, is an off-shore drilling contractor.

Present management comprised of O. C. Galloway, president; F. H. Smith, vice president; and R. Wolpert, controller, will continue to direct company activities. Howard Duke, assistant to Zapata's president, was elected to the board of directors of National Tube Coating.

Layne Associates is established

. . . in Memphis to promote progress in the development and conservation of water supplies and to provide technical information through research in the field of water. The firm is composed of members from each of the 13 Layne Associate well-drilling firms, and Layne & Bowler, Inc. Layne Associates will seek newer and better methods, through research, for finding and treating ground water in ample supply and to keep up with the increasing demands for water.

Hughes Tool Co. promotes four

. . . in a move to strengthen services in domestic and foreign areas and to give added emphasis to the company's industrial products, according to W. H. Siems, vice president of sales.

H. W. Harms

R. R. Aulick

Promoted were: H. W. Harms, manager of field-engineering services, to manager—export field engineering; Roscoe R. Aulick, manager of product observation, to product manager—industrial products; N. B. Thomas, assistant to manager of field-engineering services, to product manager—tool joints; and John R. Hays, from planning and coordination, to manager—market research.

N. B. Thomas

J. R. Hays

Oil Well Supply Division names

R. E. Dickson

. . . Robert E. Dickson manager of sales of the central midwest area, Daniel H. Barr to assistant vice president of marketing, and Stanley D. Strand as district manager at Edmonton, Alta. Dickson and Barr will locate at division headquarters in Dallas.

At the same time the U. S. Steel Corp. division announced the appointments of two store managers and a representative in the central midwest area. F. B. Mobley will head the supply store at Hobbs, N. M., and Joe L. Ward will take charge of the Big Spring, Tex. store. L. M. Roy is the newly appointed division representative at Midland, Tex.

D. H. Barr

S. D. Strand

Steve Battisto, Jr. is appointed

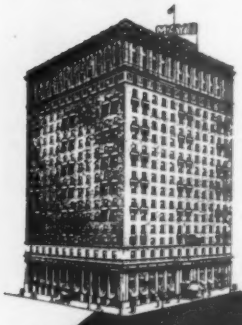
. . . assistant sales manager for T. D. Williamson, Inc., Tulsa manufacturer of pipeline pigs, tapping and stopple plugging machines, and other pipeline equipment.

Battisto joined the firm in 1957 as research and development engineer. A year later he became chief applications engineer and moved to the sales department. Before joining T. D. Williamson, Battisto was research analyst in the development test section of Douglas Aircraft engineering department.

Name change is announced

. . . by Cal-Metal Pipe Corp. of Louisiana, according to John P.

THE HOTEL



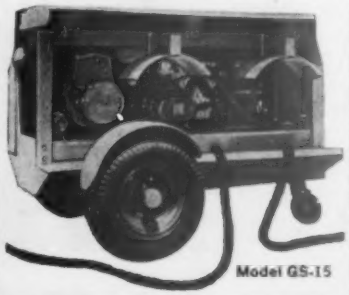
in the Oil Capital of the World

100% Airconditioned
600 Bright *Reasonably* Priced Rooms

THE MAYO

TULSA'S *Finest* HOTEL
Sample Rooms - Finest Food
Adjacent Garage

NEW PORTABLE
AIR COOLING
UNIT
FOR INDUSTRIAL USES



Model GS-15

Provides fresh refrigerated breathing air to personnel. Eliminates exposure to hazards created by contaminated air conditions that exist in the various phases of manufacturing, cleaning and maintenance processes. Provides body temperature comfort under high ambient conditions. Adaptable to any type of protective suit or coverall. Save man hours and downtime. Send for literature and specifications.

Our 27th year . . . engineering for any specific air conditioning requirement.

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Stupp, president of the corporation. Now called Stupp Corp., the Baton Rouge, La., pipe mill will be operated as a wholly owned subsidiary of Stupp Bros. Bridge & Iron Co., St. Louis structural-steel fabricator. Sole ownership was accomplished through the purchase of stock interests formerly held by Cal-Metal Corp., of Torrance, Calif.

Oil Center Tool Co. appoints

. . . two new district sales managers, according to A. C. (Bus) West, sales manager of the Houston manufacturer of well-head equipment for oil, gas, and LPG storage wells.

B. G. Barefield, formerly in O-C-T's Houston sales office, was

B. G. Barefield

Jerry Boyd

named sales manager of the Rocky Mountain district, with headquarters in Casper, Wyo. He joined the firm in 1948. Jerry Boyd, formerly a sales and service representative, was appointed sales manager of the Four Corners district, with offices in Farmington. He was employed by Magnolia Petroleum Co. before joining O-C-T in 1956.

Grady, Harcourt are promoted

. . . by Welex, division of Halliburton Co., and transferred to new locations.

J. E. Grady

George Harcourt

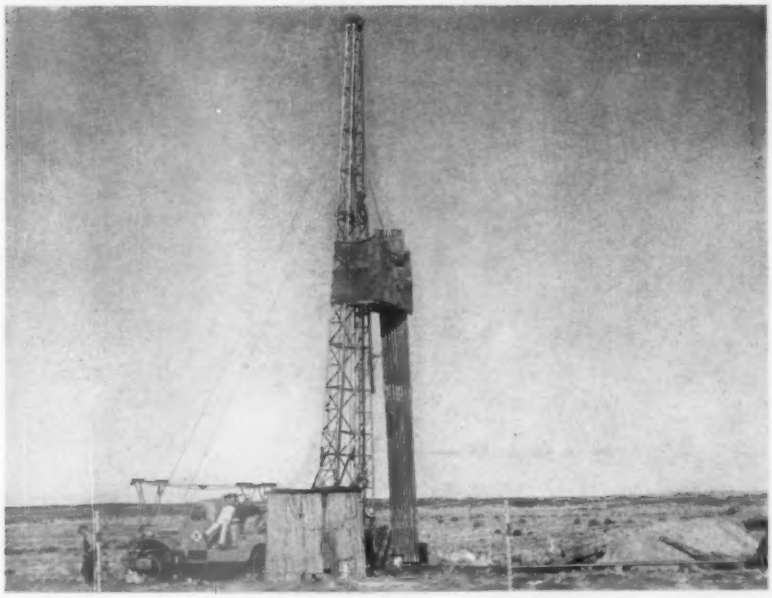
In Oklahoma, James E. Grady has been named division manager at Tulsa. Formerly area sales manager in Dallas, he has had 12 years experience in oil-well servicing. Replacing him at Dallas is George Harcourt, former Houston sales engineer. Harcourt has been associated with well servicing for 11 years.

Universal Oil Products to handle

. . . licensing arrangements for a waste-water-treatment process developed by Sun Oil Co., Philadelphia. The Sun "water-management" process will be made available to oil refiners as part of UOP's package of water-pollution-control programs.

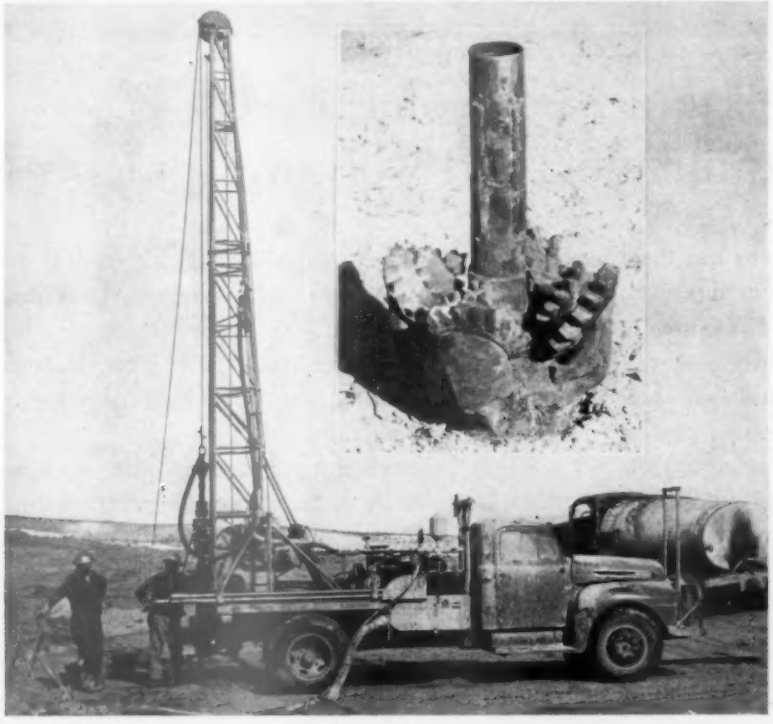
The process permits re-use of certain refinery waste water streams as make-up water in cooling towers. Through biological oxidation within the tower, concentrations of phenols and related chemicals are said to be reduced substantially.

OFFICERS AND REGENTS of the 1961 Dallas-Fort Worth Chapter of Nomads are, front row, from left: Rollo E. Davidson, regent at large; Gayle Whiddon, vice president—Dallas; Joe A. Kelly, president; W. C. Brooks, executive vice president; and R. B. Gilmore, secretary. In the back row are, from left: Leon H. Thompson, vice president—Fort Worth; K. Marshall Fagin, treasurer; J. Lewis Foster, vice president—regional; Eric Sutton, deputy sergeant-at-arms; King D. Boyd, sergeant-at-arms; Harry S. Zene, Jr., regent; and R. E. Elmore, regent. Not pictured are P. Zack Hilliard, assistant treasurer; and G. A. Holloway, assistant secretary.



HELIUM well drilling uses a portable rig.

Right side up, or . . .



DRILLING from bottom up uses unusual bit (inset) setup in uranium mines.

upside down,

Portable rigs keep busy

Here's what contractors are doing, despite the slowdown in petroleum exploration

TOPSY-TURVY DRILLING is a commonplace event in one part of the Southwest these days. Here's what some of the portable-rig drilling contractors are doing to keep busy during a slowdown period in petroleum exploration.

Normally these drills are kept busy on shot holes for seismic shooting programs or for core holes in exploratory work. With the recent cutback in exploration work, contractors are looking to other work to keep the rigs running.

Some of the rigs are actively engaged in drilling water wells. Others are prospecting for helium gas, potash, uranium, and beryllium. In the southwestern and western sectors of the country—particularly in New Mexico, Arizona, and Utah—most of the current activity is in the development of new underground mineral resources of the area.

At Navajo, Ariz., C. C. Smith Drilling Co. of Lubbock, Tex., has been drilling 1,000 to 1,200-ft. production holes for helium gas with good results. This is in the Pinta Dome area where Kerr-McGee Oil Industries, Inc., will construct the nation's first privately owned helium plant. The wells are being drilled with a Failing 1500 HD Combination Holemaster.

Another use for small rigs has been found in the drilling of vent holes for uranium mines. The Four Corners Exploration Co. of Grants, N. M. has pioneered a new method of drilling these vent holes with what they call "upside-down drilling." In this type of operation a small pilot hole is drilled with conventional methods down to the main cavern of the mine. Then a large rock bit, usually about 13¼-in. diameter, is attached in an upside-down position in the mine cavern and the hole is reamed to this size, with the bit working upwards, while the cuttings fall down into the mine.

Scott Brothers Drilling Co. of Grants, N. M. has two portable rotaries drilling exploration holes for beryllium near Delta, Utah in the Topaz Mountain district. Due to the hardness of the volcanic rock which overlies the beryllium deposits, air-hammer tools are being used extensively in these operations.

Diversionary drilling such as these operations are a healthy sign. When petroleum exploration drilling picks up again, a ready reserve of drills such as these will be available.

this Dowell tool has revolutionized well completion, stimulation and workover practices

Seldom in the history of the oil industry has there been a tool as versatile as the one used in Abrasijet*.

By directing high-velocity streams of abrasive in liquid against casing or hole wall, Abrasijet can perform many jobs not previously considered practical. First and most important, Abrasijet can be used to cut slots in casing and formation at low cost. By moving the tool during jetting, either vertical or horizontal slots may be cut to reduce breakdown pressures and to initiate fractures in the direction and plane desired. This use of Abrasijet has resulted in excellent gas/oil and water/oil ratios as well as outstanding production increases.

Second, Abrasijet has been successful in perforating wells that could not be perforated using explosives. Several thicknesses of pipe and cement can be penetrated simply by adjusting the jetting time.

Third, Abrasijet can be used in old wells completed in open hole to clean formation faces that have become plugged with various soluble and insoluble deposits. Since Abrasijet is mechanical in action, a detailed chemical analysis of the plugging deposit is not required.

Finally, there is a special money-saving application of Abrasijet. A tool with downward-pointing jets can use acid without sand to dissolve set cement in casing or tubing. In many cases this is safer and less costly than drilling out.

For detailed information on this versatile service—call Dowell. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma. *DOWELL SERVICE MARK

SERVICES FOR THE OIL INDUSTRY DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

WILDCATTING PUSHED to the North last week, as Pan American Petroleum Corp. spudded its 1 Napatuk Creek, first test of Alaska's Bethel basin, and Canada Southern Petroleums, Ltd., announced its 1 Carnwath, northernmost well ever to be attempted in Canada.

Two new provinces draw key wildcats

BY FRANK J. GARDNER

TWO of the most significant wildcats on the 1961 calendar are on the verge of spudding in. Both are in remote locations. And success at either one will open a new theater of operations for the oil industry.

In Alaska's Bethel basin, Pan American Petroleum Corp. will sink the first wildcat for that potential oil province. After having been thrown behind schedule by a warm winter season, the company has rig on location at 1 Napatuk Creek; the well site is in Section 4-6n-78w Seward Meridian. Pan Am is acting as operator at this project and holds a 26.33% interest in it; other principal participants are Empire State Oil Co., Bristol Bay Oil Co., and Sunray Mid-Continent Oil Co. Rowan Drilling Co. has the contract on this 10,000-ft. test.

In Alaska's west . . . Bethel basin lies on Alaska's southwestern coast. It covers an enormous area, and is believed to hold a great thickness of sediments, although little is known of its geologic history. It's a region of myriad lakes and very few surface outcrops, but oil companies have put more than 6 million acres of it under lease. Years ago, an aeromagnetic survey by the U. S. Government indicated a great structural trough roughly following the course of the Kuskokwim River, but there have been no deep wells to ferret out the real nature of the basin.

Pan Am's development contract for 465,280 acres in Bethel basin was approved by the Department of the Interior on September 1, 1959. The company had made preliminary investigations there in 1957 and 1958 and had taken about 180,000 acres in the river delta (these are included in the development contract).

Terms of the deal call for a minimum expenditure of $950,000 on exploration and the drilling of three wells, the first to spud no later than March 1, 1961. During 1959, Pan Am did a lot of surface exploration in Bethel, and drilled one core hole to 1,205 ft. Two more core holes were drilled in 1960, Section 27-8n-77w, to depths of about 2,100 ft. The company also conducted seismic surveys on the region last summer. The progress of 1 Napatuk Creek will be closely watched as a key to Alaska's oil future.

And Canada's north . . . Meanwhile, eastward across the Canadian border, the most northerly wildcat in Canada has been announced by Canada Southern Petroleums, Ltd. This test, the 1 Carnwath River, lies 86 miles inside the Arctic Circle in the Northwest Territories, at Lat. 67° 44′ 40″ N., Long. 128° 47′ 53″ W. It will go to 3,000 ft. on a 48,645-acre tract acquired by Canso from Pompey Oil & Minerals, Ltd.

Operators of this northernmost Canadian venture have done a great deal of seismic and photogeological work on their block as a preliminary to the drilling of the 1 Carnwath. Tri-City Drilling Co., Ltd., holds the contract for the well.

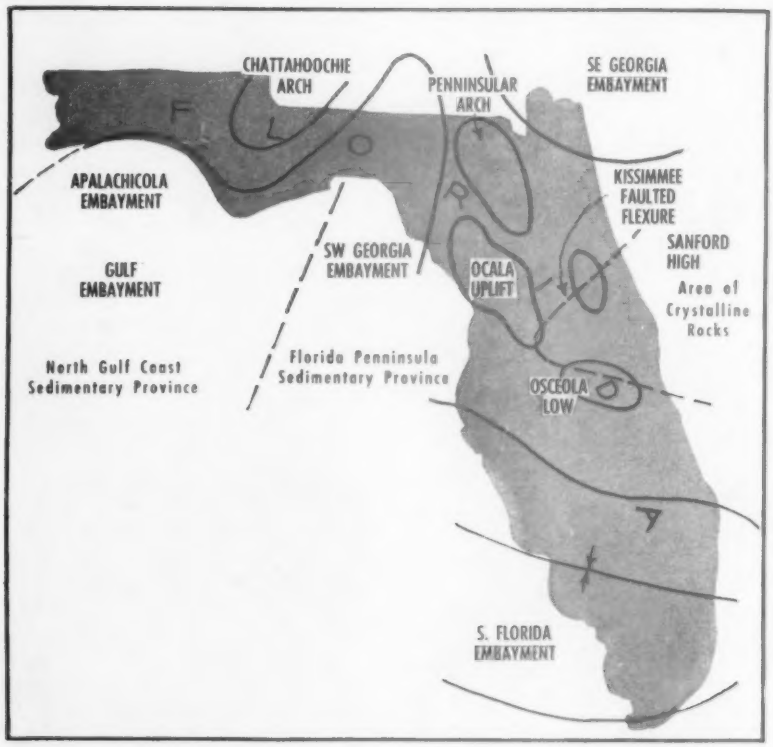
Wildcats are no novelty in these Arctic Circle lands. Last year, Western Decalta Petroleum, Ltd., drilled several tests in the Rond Lake region 50 miles to the southeast of the Carnwath. Richfield Oil Corp. has sunk important wildcats at Grandview Hills, 70 miles southwest, and at Point Separation, about 170 miles to the west.

Bold ventures start . . . Both of these Far-North operations will be of interest in the weeks ahead. For both are bold ventures in little-known provinces.

Florida—uncover big

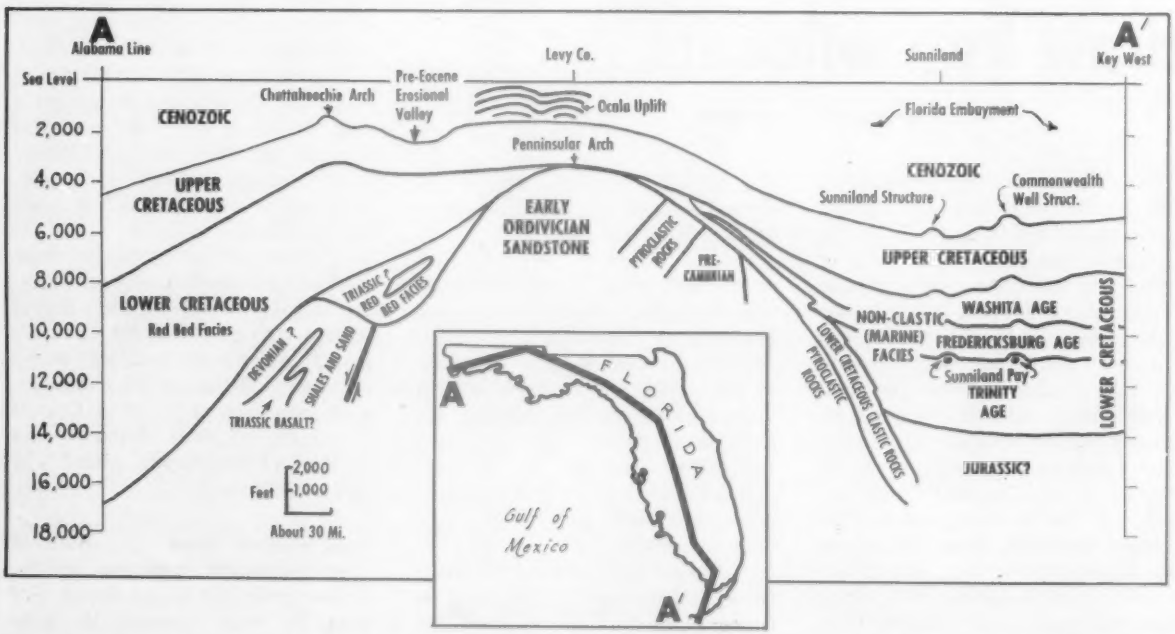
WENDELL L. ROBERTS
AND
ROBERT O. VERNON
Tallahassee

W. L. Roberts is a geologist, with Coastal Petroleum Co., and R. O. Vernon is director, Florida Geological Survey.



GEOLOGICAL PROVINCES of Florida are displayed in this map.

"Florida has a thick sedimentary section which contains oil shows and zones of porosity separated by impervious beds. The major structural features have been outlined from scattered well control."



STRATIGRAPHIC relationships of Florida beds are evident in this cross-section extending from the Alabama line to Key West.

more extensive drilling might oil and gas-producing areas

FLORIDA HAS the basic requirements to become a major oil and gas-producing state—but the oil is yet to be found in great quantities.

The state is blanketed by a known sedimentary rock section of 3,000 to 18,000+ ft. The major structural features have been outlined but control over most of the state is so sparse that interpretations are limited to those regional in scope.

Geological Setting and Structure

Florida is closely associated with the geologic processes and structures that produced the islands and adjacent mainlands of the Caribbean area. Not only do the land masses of this area have a great potential for oil production, but also the adjacent continental shelves. The recent U. S. Supreme Court decision that confirmed to Florida the rights to its submerged lands has encouraged increased interest in the possible production of the shelf.

Florida, southern Georgia, southern Alabama, Cuba, the Bahama Islands, and possibly lesser islands of the Caribbean Sea are the eastern rim of the Gulf of Mexico sedidentary basin. Pressler (1947, p. 1851) found two sedimentary environments were present in this part of the Gulf Basin, and proposed the North Gulf Coast sedimentary province for that part of the basin in which essentially clastic sediments were being deposited and the Florida Peninsula sedimentary province for the remaining part in which nonclastic sediments, predominately carbonates and anhydrites were being deposited (Fig. 1).

The North Gulf Coast sedimentary province includes the Apalachicola embayment and the Southeast Georgia embayment, whereas the Florida Peninsula sedimentary province encompasses several dominant structural features and the South Florida embayment of the Gulf basin. The center of deposition in the embayment passes through Collier County near the Sunniland field and trends about southeasterly across the state.

The Peninsular arch (Applin, 1951, p. 3) dominates the structure in rocks older than the Tertiary (Fig. 2). This gentle dome centers beneath Union and adjacent counties and trends generally northwest-southeast. It probably is the structural axis of peninsular Florida and is the rim of the Gulf basin. Paleozoic sediments ranging in age from the Cambrian through the Devonian, older crystalline rocks, and Paleozoic extrusions were folded and peneplaned at the time that the structure existed as a topographic high. Following peneplanation, sediments of Early Cretaceous age were deposited around the structure and younger sediments were deposited to overlap these formations into the Late Cretaceous when the arch was covered during Austin time.

The Ocala uplift is an Early Miocene structure and is well developed along the western part of the Florida peninsula. Its crest roughly parallels that of the Peninsular arch, but lies west of it. The Ocala uplift has been considered as a simple, elongate, double-plunging anticline, but it is intensively fractured and complicated by at least four separate structures that have deformed Tertiary and Quaternary rocks. The Sanford high, the Kissimmee faulted flexure and the Osceola low have been superimposed on the predominating Ocala uplift and Peninsular arch and upon a relatively structurally stable area of crystalline rocks (Fig. 1).

In southern Florida, the structures of the Peninsular arch and Ocala uplift merge into the South Florida embayment in which carbonate, evaporite, and argillaceous sediments have been deposited to thicknesses that exceed 15,000 ft.

In northeastern Florida and southeastern Georgia, scattered wells indicate that the structures predominating central Florida lose their identity in a thickened section of Mesozoic, Tertiary, and Quaternary sediments centered somewhere offshore.

The Ocala uplift as a gentle anticline trends northwesterly from Polk County, separates into a series of unnamed noses and troughs and terminates along a broadly developed uplift called the Chattahoochee arch. This gentle anticline crests along the Flint and Apalachicola rivers and it trends southwest-northeast. The southwest extension of the arch merges with thickened sediments deposited in the Apalachicola embayment and the Gulf embayment.

The rocks that compose Florida form a portion of the Floridan plateau, which apparently always has been a part of a continental mass, since the oldest sediments penetrated by deep oil test wells are shallow-water marine deposits formed on continental shelves and no sediments formed in deep oceanic basins are present. The sedimentary section of peninsular Flor-

"Florida is closely associated with the geologic processes and structures that produced the islands and adjacent mainlands of the Caribbean area."

"Of the 67 counties in Florida, 6 remain untouched by the drill. If only those wells drilled to a depth of 2,000 ft. or more are considered tests, 10 counties in Florida have not been tested, 13 have had only 1 test each, and only 5 counties have had more than 10 tests."

ida consists essentially of fragmental and pasty marine limestones, sandstones, and shales reaching a known cumulative thickness in excess of 18,000 ft. Only three deep wells have penetrated crystalline rocks in Florida: granite was cut by the Humble Oil & Refining Co. Carroll well in Osceola County; the Oil Development Co. Arnold well drilled granite in Lake County; and hornblende diorite was reached by the Sun Oil Co. Powell well in Volusia County. Because of their stratigraphic position and crystalline texture, Applin (1951) believed that the diorite is questionable Precambrian and the others either Precambrian or Paleozoic intrusives. From Applin's study, it can be inferred that the core of the Floridan plateau is Precambrian and that upon this rather poorly defined area dominantly marine Paleozoic sediments, ranging in age from Late Cambrian to Early Ordovician to Devonian, were formed. Twenty-seven deep wells in the state have cut sandstones of the Lower and Middle Ordovician series, the Stanolind Oil & Gas Co. Perpetual Forests, Inc., well in Taylor County penetrating a thickness of 2,250 ft. of these sandstones. Three wells cut black shales and sandstones of Lower Devonian or Upper Silurian age, the Humble J. P. Cone well in Columbia County penetrating a thickness of 906 ft. of these sediments. These Paleozoic rocks were subsequently exposed to erosion and were folded, possibly faulted and preserved in structurally low regions throughout an extensive erosional period.

The forming of the Peninsular arch during the Early Mesozoic was accompanied by downwarping in southern Florida and a thick deposit of marine and deltaic sediments, largely carbonates, ranging in age from possible Jurassic to Recent were deposited upon this land mass. Several deep oil tests drilled in Monroe County (Gulf and California—state leases) penetrated more than 15,000 ft. of limestone, dolomite, and anhydrite of Tertiary, Upper Cretaceous, Lower Cretaceous, and possible Jurassic ages, whereas wells in the vicinity of Union County penetrated only beds of Tertiary and Upper Cretaceous ages.

These wells indicate an extensive submergence of the topographic high represented by the Peninsular arch began at the south end of the peninsula during the Early Cretaceous and advanced up the peninsula with younger sediments overlapping older sediments. The marine sediments interfinger northward into clastic red and green shale, sandstone, and siltstone that cover the south flank of the Peninsular arch.

Shallow marine sediments of Paleozoic to Recent ages were deposited upon the peninsula with brief intervening periods when these sediments stood as land and were eroded. Except for the sediments of Miocene to Recent ages, these deposits are essentially carbonates with thin beds of evaporites, sandstone, and shale.

In general, the Tertiary sediments of the state are composed of two depositional facies, an essentially marine carbonate facies and a more shallow-water clastic facies, a small portion of which is also marine. The coastal plains of western Florida and states westward to Texas have been, in general, a region of active deltaic sedimentation. On the other hand, peninsular Florida, removed from large streams and continental sedimentatiton, is dominantly marine. The two extremes merge through interfingering phases in the coastal areas of Alabama, western Florida, and northern-central Florida. As the Applins (1944, pp. 1679-80) stated:

> "... on the one hand, West Florida and southern Georgia are occupied by a clastic facies which is similar in its broader aspects to the sediments of the Western Gulf Coastal Plain and is composed largely of sand and shale with some limestone and chalky marl. On the other hand, over most of the peninsula, the sedimentary section is almost continuous limestone from the top of the Oligocene into the Lower Cretaceous . . . In northern Florida and in the north quarter or north third of the peninsula, the limestone and clastic facies grade laterally into each other. In general, with the passage of time, the limestone of the peninsula encroaches upon the clastic facies, spreading northward in successive stages."

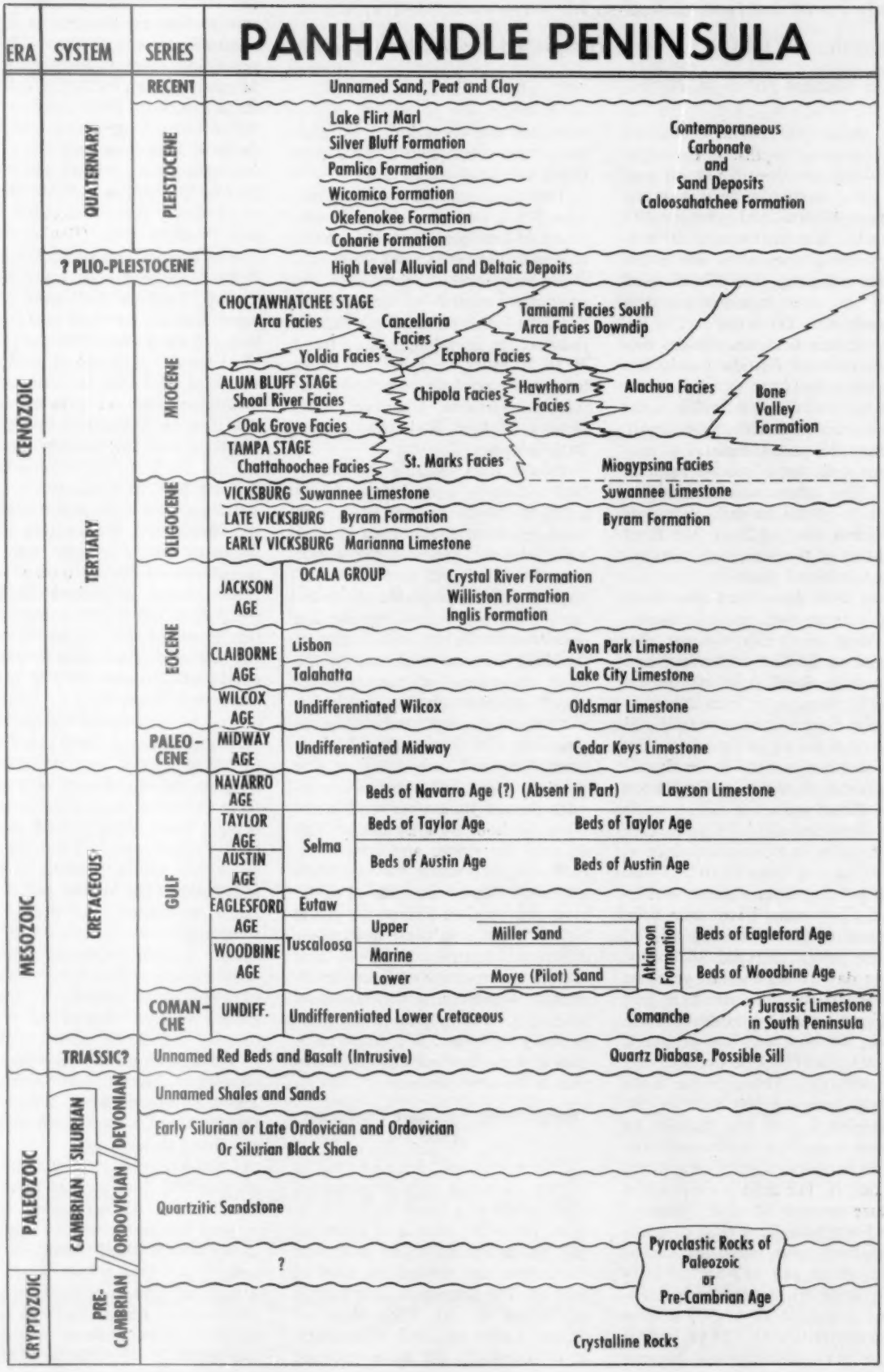
Exploration History

The search for oil started in Florida in 1900 or 1901 (Gunter, 1949, p. 6). A few wells were drilled during the next 40 years but most of them were abandoned at very shallow depths. Little was known about the deeper formations. Because the sedimentary mantle in southern Florida was generally thought to be relatively thin, it was not until 1939 that a well was drilled to a depth greater than 7,000 ft. The Peninsular Oil & Refining Co., under the supervision of the late Robert B. Campbell, geologist, (1939, p. 96) drilled to a depth of 10,006 ft. near the village of Pinecrest in Monroe County. That well marked the turning point in Florida's oil search for two significant reasons—it proved the presence of a thick sedimentary section in southern Florida and recorded shows of heavy asphaltic oil, below 9,800 ft. in rocks of Lower Cretaceous age. An unprecedented prospecting, leasing, and drilling play followed, resulting in the discovery of the Sunniland field 4 years later.

Since 1943, seismograph, gravity meter, core drill, and magnetometer crews have worked approximately 7,000 crew-weeks. Most of the state has been prospected by one or more methods and some areas have been explored several times. The results have been less than satisfactory. The writers believe that the development of a geophysical technique in Florida that can be accurately interpreted will change the present production status of the state.

Of the 67 counties in Florida, 6 remain untouched by the drill. If only those wells drilled to a depth of 2,000 ft. or more are considered tests, 10 counties in Florida have not been tested, 13 have had only 1 test each, and only 5 counties have had more than 10 tests.

Approximately 400 wells have been attempted in the search for oil in Florida since 1900. However,


PANHANDLE PENINSULA
ERA
SYSTEM
SERIES
CENOZOIC
QUATERNARY
RECENT
Unnamed Sand, Peat and Clay
PLEISTOCENE
Lake Flirt Marl
Silver Bluff Formation
Pamlico Formation
Wicomico Formation
Okefenokee Formation
Coharie Formation
Contemporaneous Carbonate and Sand Deposits Caloosahatchee Formation
? PLIO-PLEISTOCENE
High Level Alluvial and Deltaic Depoits
TERTIARY
MIOCENE
CHOCTAWHATCHEE STAGE
Arca Facies
Cancellaria Facies
Tamiami Facies South
Arca Facies Downdip
Yoldia Facies
Ecphora Facies
ALUM BLUFF STAGE
Shoal River Facies
Chipola Facies
Hawthorn Facies
Alachua Facies
Bone Valley Formation
Oak Grove Facies
TAMPA STAGE
Chattahoochee Facies
St. Marks Facies
Miogypsina Facies
OLIGOCENE
VICKSBURG Suwannee Limestone
Suwannee Limestone
LATE VICKSBURG Byram Formation
Byram Formation
EARLY VICKSBURG Marianna Limestone
EOCENE
JACKSON AGE
OCALA GROUP
Crystal River Formation
Williston Formation
Inglis Formation
CLAIBORNE AGE
Lisbon
Avon Park Limestone
Talahatta
Lake City Limestone
WILCOX AGE
Undifferentiated Wilcox
Oldsmar Limestone
PALEO-CENE
MIDWAY AGE
Undifferentiated Midway
Cedar Keys Limestone
MESOZOIC
CRETACEOUS
GULF
NAVARRO AGE
Beds of Navarro Age (?) (Absent in Part)
Lawson Limestone
TAYLOR AGE
Selma
Beds of Taylor Age
Beds of Taylor Age
AUSTIN AGE
Beds of Austin Age
Beds of Austin Age
EAGLESFORD AGE
Eutaw
WOODBINE AGE
Tuscaloosa
Upper
Miller Sand
Marine
Lower
Moye (Pilot) Sand
Atkinson Formation
Beds of Eagleford Age
Beds of Woodbine Age
COMAN-CHE
UNDIFF.
Undifferentiated Lower Cretaceous
Comanche
? Jurassic Limestone in South Peninsula
TRIASSIC?
Unnamed Red Beds and Basalt (Intrusive)
Quartz Diabase, Possible Sill
PALEOZOIC
DEVONIAN
SILURIAN
Unnamed Shales and Sands
Early Silurian or Late Ordovician and Ordovician
Or Silurian Black Shale
ORDOVICIAN
CAMBRIAN
Quartzitic Sandstone
?
Pyroclastic Rocks of Paleozoic or Pre-Cambrian Age
CRYPTOZOIC
PRE-CAMBRIAN
Crystalline Rocks

"Only 75 of the tests drilled so far have exceeded 9,000 ft. in depth. Of these, 15 were completed as producing wells for a success ratio of 20%."

only about 300 of these reached their objective depths. If the entire 400 wells are considered oil and gas tests, there has been one test for each 87,500 land acres or 137 sq. miles. If approximately 20 million water-bottom acres are added to the estimated 35,000,000 land acres, the ratio becomes one test for each 137,500 acres of 215 sq. miles. It thus becomes obvious that the surface of Florida barely has been scratched.

Only 75 of the tests drilled so far have exceeded 9,000 ft. in depth. Of these, 15 were completed as producing wells for a success ratio of 20%. Five others recovered 660 to 3,000 ft. of oil in drill-stem tests and nine recovered 20 to 365 ft. of oil. Most of the remaining tests recorded good oil shows.

Two fields have been discovered in Florida to date; namely: Sunniland field in Collier County, discovered in 1943 by Humble, and Forty Mile Bend field, discovered in 1953 through a joint effort of Gulf Oil Corp., Commonwealth Oil Co., and Coastal Petroleum Co. Both discoveries were in the Sunniland limestone of Lower Cretaceous (Glen Rose) age.

In Sunniland field 13 wells were completed with initial production figures ranging from 97 to 527 bbl. of oil per day from a depth of 11,500 ft. Two wells have since been abandoned. The remaining 11, all now on pump, averaged 96 bbl. of oil per day during the last year. At the end of the year the field had produced a total of 6,089,470 bbl. of oil. The best well had produced over 800,000 bbl.; the average well over 400,000. Although the wells produce from 11,500 ft., the oil-lifting cost is very low because an efficient water drive permits the well to be pumped from only 3,500 to 4,000 ft. The field is expected to produce another 10 to 15 years.

In Forty Mile Bend field two producing wells, with initial production figures of 76 and 112 bbl. of 20°-API-gravity oil per day, were completed at a depth of 11,300 ft. The two wells produced 32,888 bbl. of oil before abandonment became necessary due to technical difficulties. Three subsequent attempts failed to extend the field.

The Sunniland limestone averages 275 ft. in thickness and is composed of limestone, coquina, chalk, dolomite, anhydrite, and shale. Oil shows may occur in any part. As presently outlined by scattered oil tests, the favorable area in which to prospect for Sunniland oil is a trend 30 to 50 miles wide and 200 miles long with a northwest-southeast axis through Sarasota, Charlotte, Lee, Hendry, Collier, Broward, and Dade counties.

Present data indicate the Sunniland sediments were deposited in a large, shallow, evaporite basin with local relief on the bottom. Lithologic evidence indicates the waters were stratified and that high bottoms, or shoals, projected above the super saline waters. Marine life flourished in the agitated waters of the shoal areas as evidenced by the local abundance of porous limestone coquinas, chalks, and dolomites that were deposited contemporaneously with dense unfossiliferous limestones and anhydrites of the deeper, more saline waters. As a result, porous limestones and dolomites pinchout abruptly against very dense limestones and anhydrites. Following deposition these sediments were slowly compacted as the basin was loaded. Except for gentle tilting to the southwest and minor differential compaction of the beds there is no evidence of basin deformation. Therefore, in the Sunniland limestone, stratigraphic traps, particularly reef-type, and traps associated with depositional structures should be very common.

Relationship To Other Producing Areas

The Sunniland limestone is known to occur only in southern Florida below a depth of 9,000 ft. It is, however, related to other oil and gas-producing rocks of Lower Cretaceous age around the Gulf of Mexico. The Sunniland limestone is equivalent to the Glen Rose of Texas, Louisiana, and Mississippi. It is essentially the same geologic age as the producing sands at Citronelle field in Alabama, and correlates in time with the 10,250-ft. producing sand at Bolton field in Mississippi, with the 3,000 to 4,000-ft. pay at Ada, Delhi, Greenwood-Waskom, Logansport, and Sligo fields of Louisiana, with the 3,850-ft. pay at Mooringsport, the 7,200-ft. pay in Opelika, the 500-ft. pay at Holland, and the 5,000-ft. pay at Chittan in Texas (Banks, 1959).

The Florida Panhandle is geologically associated with two oil-producing trends. Sediments of the same geologic age and lithology as those of the Lower Tuscaloosa and the Lower Cretaceous oil producing trends of Alabama, Mississippi, and Louisiana, also occur in the area. The Lower Tuscaloosa trend was extended into the Florida Panhandle in 1952 by the discovery of Pollard field in Escambia County, Alabama, just four miles north of the Florida line. Exploration efforts following the discovery were directed toward finding other fault traps, similar to Pollard. In 1955 the deeper Lower Cretaceous trend was extended into the western part of the Florida Panhandle by the discovery of Citronelle field in Mobile County, Alabama.

The relationship of Florida sediments to those of Cuba can be inferred only. The Straits of Florida separate the distal part of Florida from Cuba, the short lines probably being formed along a fault trough. Cuba's Quaternary and Tertiary sediments are similar to those of Florida, being thick to thin sections of marls, limestones, and shales, with some radiolarian marls and gypsums. A well-developed Miocene orogeny, accompanied by intrusions of granodiorite, altering to serpentine, is closely related to the stresses forming the Ocala uplift.

Thick sections of shales and carbonates of Jurassic and Cretaceous age are present upon limestones, shales, marbles, and sandstones of possible Paleozoic age.

Cuba has produced some oil since about 1886 for internal use. Evidence of surface occurrence of oil is very extensive, most common along the northern coast. Several small fields have a long production expectancy and, combined with several asphalt seams that are being mined, they indicate reasonable prospects for the future. The oil

occurs generally in fractured serpentine, an altered igneous rock that has intruded Mesozoic-Tertiary sediments.

Southern Florida's petroleum possibilities are closely associated with the carbonate - evaporite sediments of the Cretaceous, differing from the oil-bearing clastics of the western Gulf Coast, but being closely related to the sediments of Cuba. Jurassic sediments are believed to be the source of the oil of Cuba by some geologists, and although Jurassic has not been identified in the Peninsula of Florida, these sediments probably underlie the state.

Future Prospects

The Sunniland limestone is the only proved producing zone in Florida. It therefore remains the most prospective zone at present.

In southern Florida previous exploration efforts in the area of the Sunniland limestone have been directed toward finding structural traps. Now, with the evidence of reef development on shoal areas and abrupt porosity pinchouts within the Sunniland limestone, it is expected that future efforts will be directed toward finding stratigraphic traps and traps associated with depositional structures.

Several zones other than the Sunniland are also expected to receive more careful study. The entire sedimentary section as it is now known contains numerous zones of porosity. The Fredricksburg above the Sunniland contains zones of porosity in which oil and gas shows have been recorded in several tests.

Below the Sunniland other prospective zones are known to occur although the number of tests that have penetrated these zones are very limited in number. In the Coastal Tiedtke well on the south shore of Lake Okeechobee, oil shows were recorded in dolomite limestone 1,500 and 2,000 ft. below the Sunniland in porous zones approximately 80 and 130-ft. thick. Similar zones have been found in the few other tests drilled to sufficient depths.

In the Florida Panhandle, the Lower Tuscaloosa and Glen Rose sands are the most prospective zones. Most of the wells in the past have stopped after testing the Lower Tuscaloosa. Since the discovery of Citronelle field a trend toward deeper drilling has developed.

In the northern part of peninsular Florida the updip pinchout of Tuscaloosa sands around the Peninsular arch offers the best potential.

Current Drilling

At this time Humble is coring below 11,700 ft. in a deep test 8 miles southeast of Sunniland field in Collier County. Good oil shows and a drill-stem test have been reported. There are indications that an attempt may be made to complete as a producing well.

California Co. and Coastal Petroleum Co. have started drilling a 13,500-ft. test 3 miles offshore near Fort Myers in Lee County. This venture should test the Sunniland limestone and zones of porosity below.

In the Florida Panhandle, Mobil Oil Co. has recently abandoned a test as dry at a depth of 12,525 ft. in Santa Rosa County. They are expected to drill another deep test in the same general area in the near future.

Humble has started drilling a 10,000-ft. test in Wayne County, Georgia. This test, the deepest test yet drilled in Georgia, will test the deeper parts of the Southeast Georgia embayment, a part of the north gulf coast sedimentary province that also includes the northeastern part of Florida.

A proposed 3,000-ft. test has been started by Strahan Drilling Co. and A. A. Anderson in Columbia County, Florida, to test the updip pinchout of Tuscaloosa sand on the west side of the Peninsular arch.

"The relationship of Florida sediments to those of Cuba can be inferred only. The Straits of Florida separate the distal part of Florida from Cuba, the short lines probably being formed along a fault trough."

Summary

Florida has a thick sedimentary section which contains oil shows and zones of porosity separated by impervious beds. The major structural features have been outlined from scattered well control. Two sedimentary provinces exist, the north gulf coast sedimentary province containing clastic sediments and the Florida Peninsula sedimentary province containing nonclastic carbonates and evaporites.

The fact that only two fields have been discovered in Florida is not surprising since the exploration well density is one well per 215 sq. miles. The success ratio of wells drilled to minimum depth of 9,000 ft. is 20%. Conditions favoring reef development are known to have existed in some areas of Sunniland deposition. Exploration efforts should not overlook the possibility of reef traps, porosity pinchouts, and traps associated with depositional structures within this zone.

The Sunniland limestone is presently the only producing zone in Florida. It therefore offers the greatest potential. Below the Sunniland limestones other zones of porosity and oil shows are known to occur. Because of the limited number of tests the environmental conditions during deposition of these sediments are not known and there is insufficient evidence to indicate the most probable type or types of traps.

The current trend toward deeper drilling in the Florida Panhandle and in southern Florida is expected to find the oil and gas needed to satisfy the one remaining requirement to Florida becoming an important producing state.

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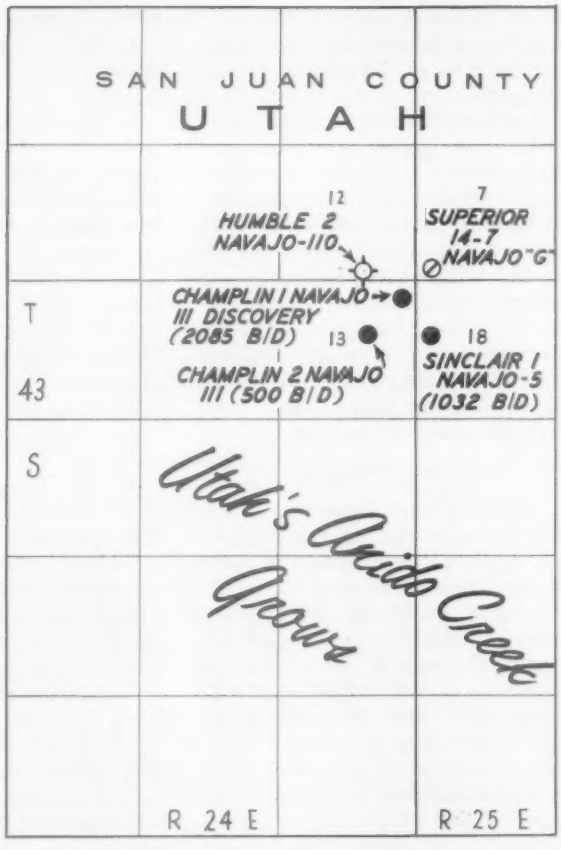
Anido Creek sparks Utah drilling

ANIDO CREEK, the discovery of the year for Utah's Paradox basin, has three producers. The newest addition is Sinclair Oil & Gas Co. 1 Navajo-5 in SW NW 18-43s-25e, San Juan County.

Sinclair's well flowed 1,032 bbl. of oil daily through ¾-in. choke from perforations in the Ismay Pennsylvanian at 5,308-23 ft. Location is in the southeast offset position to the discovery.

Champlin Oil & Refining Co.-Murphy Corp. 1 Navajo-111, C NE NE 13-43s-24e, opened the field in January, flowing 2,085 bbl. of oil per day through 1-in. choke from Ismay at 5,304-46 ft. The 2 Navajo-111, C SW NE 13-43s-24e, second well in the field, was completed in February flowing 500 bbl. per day through 24/64-in. choke from Ismay at 5,360-80 ft.



UTAH'S promising new Anido Creek field, San Juan County, picked up its third good producer.

Rockies have new centers of attention

SOME SIGNIFICANT exploratory trends for 1961 are shaping up in the Rocky Mountain states. With but 2 months gone this year, total well completions are up only in Wyoming (166/163) Montana (65/44), and West New Mexico (112/111) over 1960 comparative figures. The increase in Wyoming figures is noteworthy because this is a trend that has been going on for the past decade. The increase in Montana is a reverse of last year's development, while the New Mexico figures is much too close for any conclusions. In states that show definite exploratory programs like Montana and Utah and Nebraska, completions are down. But subsequent development should change these lower figures in a few weeks.

New interest. There are several areas of intense exploratory interest in the Rockies this first quarter.

At Anido Creek, the year's first and biggest find in the region, Champlin Oil & Refining Co. got 500 bbl. per day at the first offset to the field discovery well, completed early in January. This Utah Paradox basin discovery flowed 2,085 bbl. per day. A second extension try northwest of the field opener found less success in the Pennsylvanian. Champlin's newest success at the 500-bbl. well is a southeast extension, opening up a sizable area for further development. A lot of acreage here hasn't been touched on both sides of the state line, Utah and Arizona. Anido Creek should spark a considerable amount of drilling capacity in the southern Paradox basin this year. It rates as the most important basin strike since Ratherford-White Mesa-McElmo Creek.

In Lisbon field, first Pennsylvanian production was tapped in January, giving this northern Paradox basin field a new pay. Other production is from Mississippian and Devonian. This field should see some more development this year, mainly in the Mississippian and Devonian pays.

Williston basin. This basin's Tule Creek find in Roosevelt County, northeastern Montana, is still the year's big question mark. At first everyone thought a big play would erupt here, but activity now appears to be headed for lesser amounts than earlier predicted, unless someone gets a big one.

Humble asked for 160-acre spacing at Tule Creek. The Humble application suggests field limits, and also requests that development on the suggested 160-acre pattern allow the operator, at his option, to drill the required well in the approximate center of either the southeast or northwest quarter of each (quarter section) spacing unit.

Dwyer field, another Williston basin hot spot, may steal some of Montana's glow. Recent developments on the Montana-North Da-

kota state line hint a successful venture. One well south of production in the northwest part of the 1960 discovery area found oil, and Hunt Oil Co. has an apparent oil find about 4 miles northeast of Dwyer's discovery well. Hunt's well is in Williams County, North Dakota. Both strikes found oil in the Mississippian. An extension well on the northwest side of the field itself also found oil.

A wildcat to watch in North Dakota is Shell's 13,000-ft. test in Billings County. Deep exploration has been sporadic in North Dakota, but it has paid off in such places as Beaver Lodge, Bear Den field, and Charlson.

Nebraska. Although completions are down in Nebraska, the Cambridge arch country will still see a big drilling play this year. A 40-acre spacing decision will help this.

Operators will also drill twin wells to Pennsylvanian and Cambrian, rather than make dual completions. Counties included in the expected push are Redwillow, Harland, and Frontier.

Wyoming. Wyoming is unusually quiet this winter, but an oil well was completed between Coyote Creek and Donkey Creek fields in the Powder River basin part of the state, moving the play here into action. Patrick Draw field in Green River basin continues to grow northward with no limits in sight. An Almond Cretaceous sand oil producer was completed west of Table Rock in the same basin, and Pennsylvanian production in Raven Creek field, Powder River basin, continues to increase.

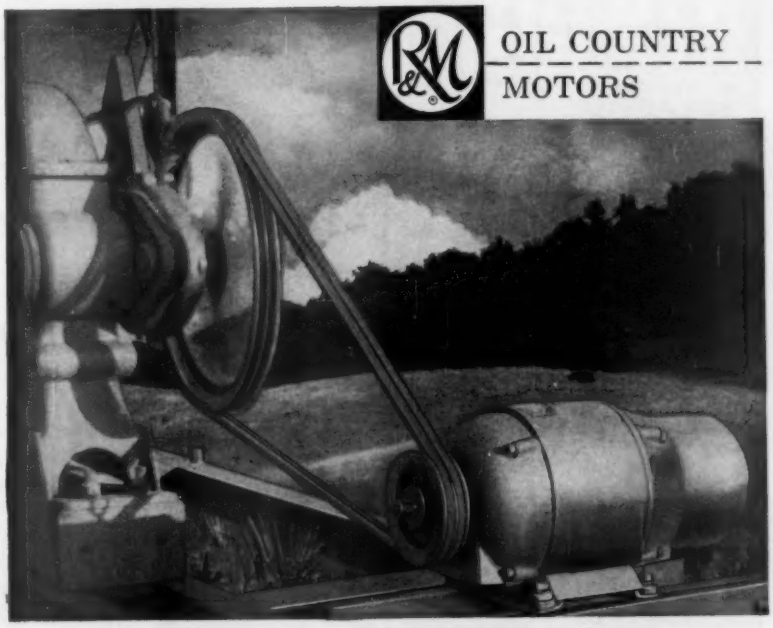
Tests to keep an eye on in Wyoming include a 11,700-ft. test to Precambian in Silvertip field, northern Big Horn basin; a 10,000-ft. Lance Cretaceous test in Wind River on the Hiland unit by Humble; a north extension to Robinson Ranch field in northeastern Wyoming.

Colorado. Completions are down here, but important gas developments are noted in Mesa County in the Piceance Creek basin where Frontier Refining Co. got 25,500 M.c.f.d. from Morrison Jurassic at 1 Christiana - Government, 2 miles northwest of Asbury Creek field. In the southeast corner of the state's Anadarko basin area, a 2,225-M.c.f. gas discovery was completed in Pennsylvanian in Baca County, 14 miles west of Kansas' Greenwood field, one of the Mid-Continent gas giants. Horizon Oil & Gas Co. completed 1-15 Homsher flowing 2,700 M.c.f.d. to extend Midway field ¾ mile northeast, Baca County. The discovery well was completed last year flowing 8,450 M.c.f.d. from Topeka and Morrow. A 1-mile northeast stepout flowed 1,750 M.c.f.d.

Atoka Pennsylvanian gas discovery finaled in N. M.

Eastern Eddy County in Southeast New Mexico has new Atoka Pennsylvanian gas production at a field opener, 4 miles southeast of Loco Hills.

Discovery is Odessa Natural Gas Co. 1 El Paso-State in 36-17s-30e, on the southeast edge of Shallow Premier field. The well flowed 6,200 M.c.f.d., and condensate from perforations at 11,357-71 and 11,448-60 ft. There is no near deep production.



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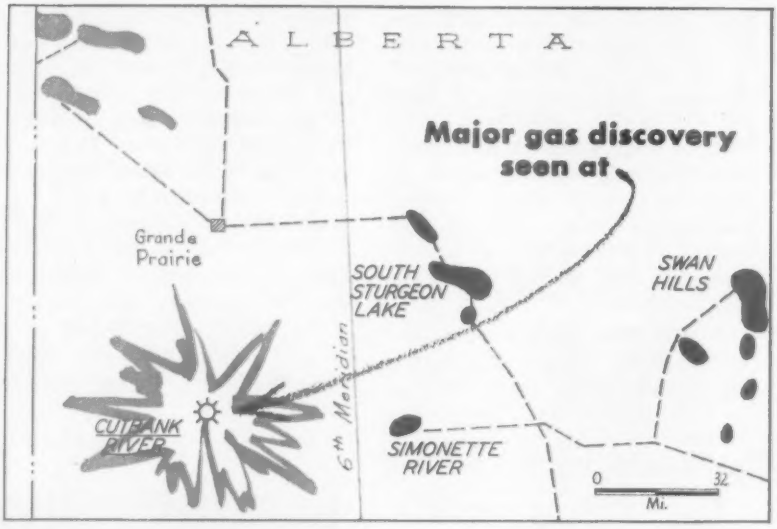


NORTHWESTERN ALBERTA has an indicated gas discovery of possible major proportions at Cutbank River.

Northwest Alberta wildcat tops Banff Mississippian gas

CUTBANK RIVER, a wildcat in northwestern Alberta, 225 miles northwest of Edmonton and 45 miles south of Grande Prairie, is reportedly a gas discovery.

Texaco Canada, Ltd., et al. 7-33 Cutbank River, LSD 7, 33-64-7w6, found high-pressure sweet gas in the lower 3 ft. of the hole, bottomed at 13,303 ft. The well lost circulation, and the hole bridged. Operators cemented the bit in the hole before trying to free the stuck drill stem. Evaluation of the gas zone will begin as soon as possible. Well is bottomed in the Banff Mississippian.

Melvin River. Pan American Petroleum Corp. is reportedly putting up pump at the northernmost producing area in Alberta, Melvin River.

During swabbing, the well kicked off and flowed oil, intermittently, from Slave Point Devonian. Further tests will be made once the pumping equipment is up. Successful completion of this well would give Alberta its northernmost production.

Coring operations are under way at Pan Am A-1 Caribou East, 13-1-117-11, a wildcat in the general area. Drilling is also under way at 6-34 Elizabeth River. The Caribou East wildcat is 16 miles east of the Melvin River well.

Alberta has string of strikes

EXPLORATORY DRILLING in Alberta over a recent 4-day period had its best rate of success in some time as no less than four wells were reported as indicated crude-oil or natural-gas discoveries.

While none of the wells could be classed as "earth-shattering," the existence of oil in any wildcat test provides further incentive, not only in the well itself but also in the surrounding districts. It is interesting to note that in all cases the wells are in the central or southern sectors of the province. That in itself is quite remarkable as in the winter drilling season the largest concentration of exploratory work is being carried out in the north and northwestern parts of Alberta, northeastern British Columbia, and the Northwest Territories.

Pembina. Probably the most significant of all the recent strikes referred to above occurred in the general Pembina district of Central West Alberta. The discovery hole, being

drilled by the team of Texaco Exploration Co. and Texaco Canada, Ltd., found what eventually could turn out to be a prolific wet-gas pool in the Nordegg member of the Jurassic horizon. Drill-stem test in that section, which was contracted at the 6,450-ft. level, gave a maximum gas blow of 7,200 M.c.f.d. during the 60 minutes valve was open. The test, which was run of a 35-ft. interval, also gave up 3 ft. of condensate.

This venture, Texaco-Texcan 10-21-51-9 Sinkhole, on LSD 10, 21-51-9w5, is 4 miles north of the closest oil production in Pembina-Cardium sand pool, and 2½ miles southeast of the Pan American A-1 East Cynthia Crown Mississippian oil discovery which was abandoned in 1957 after producing crude at marginal rates for 3 years. It was originally slated to test all horizons to the Mississippian, but after finding the main objective, water-laden casing will be run and the well completed from the Nordegg.

Trochu. Sun Oil Co. was responsible for one of the other strikes, as its 14-22-33-23 Trochu test, in the central plains region of Alberta indicated oil success in the basal Quartz-Blairmore horizon. A straddle-packer test of a 25-ft. zone immediately below 4,950 ft. gave a small blow but a pipe recovery consisting of 570 ft. of 37°-gravity crude, 60 ft. of gassy mud-cut oil, 90 ft. of gassy heavily oil-cut mud and 270 ft. of watery mud. The watery portion of that mud is believed to be from filtrate and not from the formation. Once the test was completed, drilling was resumed and the well is now through the D1 zone of Devonian heading for its prime objective—the D3 reef sector.

Drilled on LSD 14, 22-33-23w4, the well is 65 miles northeast of Calgary, 2 miles north-northwest of the Ten Oils 1 Trochu exploratory abandonment and 16 miles east of Devonian oil production in Wimborne field.

Red Deer. The team of Canadian Fina Oil, Ltd., Calvan Consolidated Oil & Gas Co., Ltd., Western Leaseholds, Ltd., Great Plains Development Co. of Canada, Ltd., and Canadian Superior Oil of California, Ltd., with a wildcat test 1 mile south of Red Deer's city limits, also found encouragement. The D2 zone of Devonian, which already is productive on the eastern side of Red Deer, gave up 360 ft. of oil and gas-cut drilling mud and 335 ft. of highly gas-cut oil emulsion. While that test could be considered as no more than a showing from a depth of 7,330 ft. a further evaluation will be made of the next 20-ft. interval immediately below and should go a long way in determining the commercial worth of the strike.

The Red Deer well is going down on LSD 7, 5-38-27w4, as an 8,500-ft. test of Beaverhill Lake possibilities. As well as being close to the D2 oil production on the east side of the city, Canadian Fina's 2-11-38-27 D3 Red Deer oil discovery well is 4 miles northeast.

Airdrie. The other exploratory success was drilled by the team of Canadian Homestead Oils, Ltd., Canadian High Crest Oils, Ltd., and other unnamed participants. While the significance of the well is not entirely known as yet, the zone from which oil was recovered could spark

further evaluation of the horizon at future tests in the area. The test was drilled in the Airdrie area of southwestern Alberta and found a stray sand in the second White Specks. To date, the well has produced over 100 bbl. of crude from the section during production tests but is currently waiting for battery installation so more extensive flow tests can be conducted.

Drilled as a Mississippian evaluation, the well, Homestead et al. 10-31-26-1 Airdrie on LSD 10, 31-26-1w5, is on the "Cardium" trend just north of Calgary's city limits and in addition to the "stray" sand will also be evaluated in the Cardium as well as there is an approximate 4-ft. sand present which appears to have porosity and oil staining. It lies immediately between the closest Cardium oil production in the Crossfield field and Western Leaseholds' 8-34 Beddington—another Cardium-sand oil well. Those two producing areas are 15 miles apart along the Cardium-sand trend which runs from southeast to northwest.

Drilling action in S. W. Alberta hinted

Watch for a sudden burst of drilling activity in the Waterton Park gas and oil-producing area of southwestern Alberta. Although no drill sites have yet been selected it is understood from very reliable sources that main operator in this area, Shell Oil Co. of Canada, Ltd. will swing six rigs into activity in the region very soon.

The rigs are currently being contracted. The new holes, mainly development tests, will have to be started soon if they are to be completed in time to start gas delivery to Alberta & Southern Gas Co. by November 1 of this year. Shell's gas-development program was advancing very favorably at Waterton Park until an oil well was punched down on the west flank of the Sheet III Mississippian gas field. This has changed the proved reserves figure considerably and the company, or companies in the area will have to drill additional wells to meet contract requirements. One current wildcat in the general area, Pan American's 7-27-6-3 Byron test, on LSD 7, 27-6-3w5, at the north end of the proved gas area could solve a lot of problems if it discovers gas. And it is presently at a testing stage in the Mississippian.

Shell Oil filed application for permit to build gas-processing facilities with the Alberta Oil & Gas Conservation Board during the second week of February and will need approval of its $20 million plant capable of processing 120 M.M. c.f.d. of raw gas is to be completed late this fall. Bids are presently out for this plant and a very tight spring construction schedule is planned.

Ontario's Norfolk County adds six gas strikes

Six successful gas wells have been recently drilled in Norfolk County, Ontario. Bluewater Oil & Gas, Ltd., announced in a special report to its shareholders on February 15, 1961.

The wells were drilled on a 10,000-acre farmout from Union Gas Co. of Canada, with whom Bluewater has a contract for the sale of all the gas from this acreage with a minimum annual sales volume of 600 M.M.c.f. Three of these wells, which were successfully fractured, gave an open flow of 1.4 M.M.c.f.d. with a daily average production rate of 400 M.c.f. and were placed on production on February 11. Bluewater has acquired an additional 5,000 acres in this area.

It also stated that during 1960 two wells were drilled on Pelee Island, one of which resulted in an indicated gas and oil well. Production tests on this well have been deferred until the spring breakup. A well drilled in Middlesex County was dry and abandoned.

The company has acquired over 15,000 acres in leases in the Princeton district, Oxford County.

Most of Michigan wildcat land taken by independents in February state-lease auction

Independents, relatively new to Michigan, dominated the buying at the February state lease auction as 86,110 acres of wildcat land was leased for a bonus of $87,645 to average $1.01 an acre.

C. W. Sharp of Shreveport, La., paid $25,697 bonus for 18,359 acres to outbid all others. C. J. Simpson of Dallas, bid in 8,997 acres for $4,134 bonus and Kenneth Newton of New Orleans, took leases on 8,663 acres for $14,231 bonus. C. G. Davis of Magnolia, Ark., was fourth in total acreage with 7,151 acres at $11,472 bonus.

The average price for the sale compared to 94 cents an acre last September. Where competitive interest was keen prices ranged from $2 to $10 an acre but the minimum bid of $1 a tract was adequate in most cases.

State leases are written for a 10-year term and require a 50-cent rental, payment on delivery, with $1 an acre for the remainder of the term.

Only 40% of the acreage offered, 213,000 acres in all, received bids either because it had suddenly cooled off or because it was requested to be posted only as a trial balloon in the first place.

In the top 10 buyers besides Sharp, Simpson, Newton, and Davis were Natural Gasoline Corp., Sinclair, Texaco, Merrill Drilling Co., Muskegon Development Co., and R. W. Koontz.

Operators took acreage in Alcona, Alpena, Antrim, Arenac, Benzie, Charlevoix, Clare, Crawford, Gladwin, Iosco, Kalkaska, Missaukee, Montmorency, Newaygo, Oceana, Ogemaw, Sanilac, St. Clair, and Wexford counties.

Texas' Matagorda gets deepest production

A new gas discovery by Sinclair Oil & Gas Co. in western Matagorda County, Texas Gulf Coast, opens the deepest production so far found in that county.

Pay zone, in the lower Frio section, is perforated at 12,561-69 ft. and 12,574-87 ft. The well was drilled to 14,000 ft. Casing was run to 12,999 ft.

During a preliminary drill-stem test of these intervals, the well (1 John T. Jones) flowed at the rate of 1,050 M.c.f.d. through 9/64-in. choke. Condensate recovery was 2

FEBRUARY MULTIPLE COMPLETIONS

	Dual oil	Dual gas	Dual oil & gas	Triple oil	Triple gas	Quad. gas-cond.	Quad. gas	Triple oil & gas	Triple gas-cond.	Quad. oil	Dual gas-cond.	Dual oil & gas-cond.	Set. oil & gas
Arkansas	..	1	..	..	..	..	..	..	..	..	..	..	..
California	..	2	..	..	..	..	..	..	..	..	..	..	..
Colorado	..	2	..	..	..	..	..	..	..	..	..	..	..
Kansas	..	..	1	..	..	..	..	..	..	..	..	..	..
Louisiana	12	2	3	1	1	1	1	1	..	..	..	..	..
North	..	..	..	..	1	1	..	..	..	..	..	..	..
South	11	2	3	..	..	..	1	..	..	..	..	..	..
Offshore	1	..	..	1	..	..	..	1	..	..	..	..	..
Mississippi	3	..	..	..	..	..	..	..	1	..	..	..	..
New Mexico	3	1	5	1	..	..	..	..	..	..	..	..	..
Oklahoma	32	1	3	3	..	..	..	..	..	1	4	2	..
Texas	25	26	5	7	2	..	..	5	..	2	4	4	1
South	7	19	3	..	2	..	..	2	..	..	..	..	1
Gulf Coast	6	2	1	2	..	..	..	..	..	2	4	4	..
East	5	1	..	3	..	..	..	2	..	..	..	..	..
West-Central	1	..	..	..	..	..	..	..	..	..	..	..	..
West	3	2	..	..	..	..	..	..	..	..	..	..	..
North	1	..	1	2	..	..	..	1	..	..	..	..	..
Panhandle	2	2	..	..	..	..	..	..	..	..	..	..	..
Wyoming	1	2	..	..	..	..	..	..	..	..	..	..	..
Total U. S.	**76**	**37**	**17**	**12**	**3**	**1**	**1**	**6**	**1**	**3**	**8**	**6**	**1**

Total multiple completions = 172
Total multiple completions Jan. = 108

bbl. flowing pressure registered 2,200 psi.

Location is near the Jackson County line, and about 9 miles southeast of Francitas, in that county. It is about 1½ miles northeast of the one-well Buttermilk field, productive from perforations at 8,556-70 ft. and 8,570-82 ft.

Gap between Texas fields is closing

A LONG STEP has been taken in filling in a 30-mile gap in the Lopene trend of deep Wilcox gas fields being developed along the Zapata-Jim Hogg county line, in southwestern Texas.

A new deep gas discovery by Gulf Oil Corp. is 8 miles from the nearest Wilcox field along the trend on the north, and more than 15 miles from the nearest comparable field on the south.

Gulf's discovery is rated one of the most significant developments in the past 2 years, not only along the deep Wilcox trend, but also over the entire Rio Grande Valley area.

The well, 1 Hector Vela, opens the deepest Wilcox production so far found. Producing depth is 12,272-82 ft. Total depth of the hole is 14,034 ft.

Open-flow potential of the well is rated by 12,200 M.c.f.d. In actual tests, the well's flow gas was 4,075 M.c.f.d. through 11/64-in. with pressure of 7,091 psi., and 2,019 M.c.f.d. through 7/64-in. choke pressure of 8,050 psi. Shut-in pressure is 9,025 psi.

Location is close on the county line just east of the old shallow Martinez gas field, productive since 1929 from the Hockley formation.

Nearest deep Wilcox production to the north is the Northeast Thompsonville field, discovered by Austral Oil Co., Inc., in 1959, and now being developed actively by Atlantic Refining Co., Standard Oil Co. of Texas, and Coast States Gas Producing Co. Its pay is at depths of 9,500 to 9,700 ft.

Louisiana adds new production in four sites

New production has been opened in four more South Louisiana areas.

A wildcat drilled by Texaco Inc. at 1 Thibodeaux, 3½ miles southeast of St. Martinville field, in St. Martin Parish, tested for 2,100 M.c.f. of gas and 38 bbl. of 49.7°-gravity condensate daily from perforations at 13,787-91 ft. Total depth is 16,500 ft.

Mississippi River Fuel Oil Corp. 1 State Lease 3503 tapped a new gas reservoir in the Atchafalaya Bay area, St. Mary Parish, with a flow of 4,175 M.c.f.d. of gas, making 14.16 bbl. of 53.5°-gravity condensate per M.M.c.f., from pay at 10,714-20 ft.

A ¾-mile south outpost test from Melodia field, in Lafourche Parish, flowed 2,225 M.c.f. of gas and 343 bbl of condensate per day through 9/64-in. choke with pressure of 9,500 psi. Completion is in pay at 14,106-12 ft. in hole drilled to 14,860 ft. Robert Mosbacher is the operator. The well is 1 Leah M. Ledt. The fourth discovery is by South Shore Oil & Development Co. at its 1 Fitzhugh, 3½ miles west of East Bugler, in northern Calcasieu Parish. The well flowed 140 bbl. daily through ⅛-in. choke from perforations at 8,582-90 ft.

Discovery wells

WEST TEXAS

Andrews County:
Texaco Inc. 1 R. M. Means, 6 miles east of Andrews in Sec. 21, Blk. 3, PSL Sur. IPF 229 BOPD, 32/64-in. choke, 43.3°, GOR 993:1, TP 250 psi., packer, Penn. 10,612-25 ft. TD 14,273 ft. New oil discovery.

Ector County:
Texaco 1 W. E. Cowden, NCT 2, 6 miles west of Odessa in Sec. 29, Blk. 43, T-2-S, T&P Sur. IPF 170 BOPD, plus 10% water, ¾-in. choke, 34.3°, GOR 280:1, packer, Wolfcamp 8,224-44 ft. TD 9,450 ft. New oil discovery.

TEXAS PANHANDLE

Lipscomb County:
Ambassador Oil Corp. 1 Max A. Blau, 8 miles southeast of Booker in Sec. 941, Blk. 43, H&TC Sur. IPAOF 15,750 M.c.f.d., 10 BCPMMCF, SIP 1,490 psi., Douglas sand 5,890-5,903 ft. TD 9,838 ft. New gas-condensate discovery.

Harry A. Jarvis

Jarvis Has Hard Job Ahead

. . . as Creole's new president. The current oil climate in Venezuela is dreary. But he takes optimistic view.

ONE of the toughest top jobs in the oil industry has been taken over by a veteran refining man from Maryland who has spent more than half his life in South America.

He is Harry A. Jarvis, 51-year-old president of Creole Petroleum Corp.—the biggest crude producer in the Jersey Standard family and Venezuela's leading oil company.

Jarvis takes over at a time when oil-company profits and capital investments are slipping in the free world's second biggest oil country.

The problems that Jarvis must live with are brought into sharp focus in a new report by Venezuela's Chamber of the Petroleum Industry. Net income of oil companies fell to $390 million last year, down from $427 million in 1959 and $523 million in 1958. The ratio of company to government earnings was about 69-31, as recognized by the Venezuelan Government.

Capital investments by the industry were pared to $317 million from $391 million in 1959 and $579-million in 1958.

Jarvis says last year's income on net worth was probably 13 or 14% on capital investment, This, he says, is rapidly approaching a minimum for a foreign investment. If the percentage declines much more, it will be preferable to invest in domestic operations.

But Jarvis believes the decline in capital investments may have bottomed out. He says spending—now at a minimum—may remain at about the same level this year as last, or even rise. He points out that one reason for the decline over the past 2 years is that most companies have completed rounds of expansion, and can increase output without further investment. About 1 million barrels daily is shut in.

Jarvis has not lost confidence in Venezuela. Creole, like companies the world over, is waiting for a general improvement in conditions. He hopes, if Creole can stay competitive, that it can hold present business and get a share of increased markets.

Jarvis looks for Creole production this year to remain at essentially the same level as 1960, when output averaged 1,093,900 bbl. daily. This was down 14,900 bbl. daily from 1959, but Jarvis considers this a normal fluctuation.

Background . . . Virtually all of Jarvis' career has been spent in South America. He was born at Berlin, a small town on Maryland's eastern shore. He attended the University of Maryland and graduated in 1930 with a degree in mechanical engineering.

From June 1930 to January 1931, he served as a student engineer at Esso's Bayway refinery. Then he transferred to Argentina where, in 16 years, he rose from junior engineer to the head of the refinery.

Jarvis went to Venezuela in 1947 as the first manager of Creole's Amuay refinery. He became manager of Creole's refining department in 1949. He was elected to the board of directors in 1952, and was named executive vice president in 1954.

A sports enthusiast, Jarvis enjoyed riding horses in Argentina, and sailing at Amuay. Favorite pastimes now are golfing and hunting.

●

Paul F. Johnson, production foreman for Ohio Oil Co. in Grass Creek, Wyo., has been promoted to district engineer in Sidney, Neb.

Richard C. Byrd, Ottawa, Kans., has been named to the Kansas Corporation Commission replacing **J. Robert Wilson,** whose interim term expires March 20. Byrd, a former commissioner, is expected to become chairman.

D. W. Jackson has been named chief production engineer in charge of the production and engineering division in Panhandle Eastern Pipe Line Co.'s production and gas-supply department. Also in this department, **M. E. Shaw** has been named chief storage production engineer, storage production engineering division, and **T. A. Abouhalkah** has been named chief storage reservoir engineer, storage reservoir engineering division.

▶▶▶ Personals

Donald S. Stone, special geological consultant with California Oil Co., has joined McElroy Ranch Co. as Rocky Mountain division geologist. He will headquarter in Denver.

W. W. Crump, seismic party chief for Amerada Petroleum Corp., has been transferred to McCook, Neb., from Wray, Colo.

Cecil B. York, district production superintendent for Sinclair Oil & Gas Co., has been transferred to Ardmore, Okla., from Chase, Kans.

Gerald B. Eckley, Denver division land manager for Shell Oil Co., has been named Oklahoma City division land manager. He succeeds **Ralph Floyd,** now on special assignment.

E. L. Hlinak, assistant director of Continental Oil Co.'s Ponca City, Okla., process center, has been promoted to director of new petrochemical projects. He will headquarter in Houston.

A. J. Welborn, independent producer in the West Texas-New Mexico and Rocky Mountain areas, has moved his headquarters to Dallas from Fort Worth. Welborn was with Gulf Oil Corp. before becoming an independent in 1950. He has headquartered in Lubbock, Denver, and Fort Worth since that time.

Paul E. McGovney, vice president in charge of Canadian operations for Honolulu Oil Corp. with headquarters in San Francisco, has joined Clark Oil & Refining Co. as vice president in charge of the exploration and production division. He will headquarter in Denver.

C. D. Hudson, area reservoir engineer for Atlantic Refining Co. in Corpus Christi, Tex., has been named chairman of Southwest Texas section of AIME's Society of Petroleum Engineers. He replaces **J. N. Holland,** Rockwell Manufacturing Co., who has been transferred to Houston. Hudson had been vice chairman of the group.

W. A. Russell, production foreman with Sinclair Oil & Gas Co., has been transferred to Lovington, N. M., from Midkiff, Tex.

S. W. Clark, exploitation engineer for Shell Oil Co., has been transferred to New York from Midland, Tex.

James A. Latham, formerly senior reservoir engineer for Arkansas Fuel Oil Corp., has resigned to open offices in Shreveport, La., as consulting petroleum engineer.

Douglas Preble, senior geologist with Columbian Carbon Co., has joined **Byron M. Finch,** Charleston, W. Va., oil and gas consultant, as geologist.

Glen N. Hile, senior consultant, plant and gas operations, for The California Co. division of California Oil Co., has retired after 37 years with the Standard Oil Co. of California companies.

W. J. Chamblin, R. L. Jackson, and **E. L. King** have been named assistant division development geologists for California Co. division of California Oil Co. Chamblin is assigned to the South Louisiana division; Jackson to the southeastern division; and King to the delta Gulf Coast division. **K. A. MacIvor** has been named area development geologist in the delta Gulf Coast division, and **J. E. Siegmund** has been named area development geologist, South Louisiana division.

Frank J. Hardesty, chief petroleum engineer for the Long Beach, Calif., harbor petroleum and subsidence - control administration, has been named assistant to **M. D. Hughes,** director. Hardesty's post is a new one formed in reorganization of harbor department subsidence operations. In other changes, **Dr. Manuel N. Mayuga,** assistant chief petroleum engineer, technical services, has succeeded Hardesty. **George C. Hilty,** assistant chief petroleum engineer for drilling and producing operations, will succeed Mayuga. **L. W. Brock,** principal development engineer, has succeeded Hilty. **William A. Smith,** assistant administrator, has been named assistant chief petroleum engineer for subsidence-control operations.

CHANDLER

DERBY

H. H. Chandler, general manager of Texaco Iran Ltd. in London, has been named assistant to the president of Texaco Inc. with headquarters in New York. **Landon B. Derby,** vice president in charge of Texaco's foreign operations department (Western Hemisphere and West Africa), has been named to succeed Chandler in London. **W. Henry Ryer,** manager of foreign crude - oil purchases and sales for Texaco, has been elected vice president, foreign operations department. Chandler and Derby had held their former posts since 1959. Ryer had been manager of foreign crude - oil purchases and sales since 1956.

RYER

Jack W. Hailer has been promoted to process-engineering supervisor for El Paso Natural Gas Products Co. He succeeds **Keith Claiborne,** now technical - services supervisor.

Kelly H. Gibson, Pacific Petroleums, Ltd., has been elected chairman of Canadian Petroleum Association's British Columbia division. **E. W. Scott,** Union Oil Co., and **J. H. Van de Venter,** Western Natural Gas Co., have been named vice chairmen. Directors elected for a 2-year term include Gibson; Van de Venter; **F. C. Osment,** Pan American Petroleum Corp.; **G. T. Pearson,** Hudson's Bay Oil & Gas Co.; and **John S. Poyen,** Imperial Oil. Directors elected for a 1-year term are Scott; **F. Brett,** Sinclair Canada Oil Co.; **K. R. Joynt,** Mobil Oil of Canada; **S. T. McCardell,** Texaco Exploration Co.; and **W. F. Mugler,** Richfield Oil Corp.

Personals

H. J. Shumate, contract manager for foreign operations of Loffland Brothers, has been elected a vice president of the company. Shumate will continue to headquarter in New York and to act as foreign contract manager, a post he has held since 1959. Shumate was with Gulf Oil Corp. before joining Loffland's southwest division.

Derby Refining Co. has consolidated its crude-oil purchasing and pipeline departments and named **John F. Beardslee** manager of the resulting new department. Beardslee had been manager of the crude-oil purchasing department. **L. E. (Ed) Woods,** pipeline superintendent, has been named assistant manager of the consolidated department.

Bob J. Beard has been named executive vice president of Gulf Resources, Inc., and manager of the company's natural-gas pipeline operations in South Texas. He will headquarter in San Antonio. Beard is also general manager of Jonnell Gas Co.

George E. Conner, president of Milwhite Mud Sales Co., has been elected a director of Mississippi River Fuel Corp.

Ralph T. McElvenny, president and chief executive officer of Michigan Consolidated Gas Co. and American Natural Gas Co. has been elected a director of Parke, Davis & Co.

James B. Henderson, vice president and general counsel of Transcontinental Gas Pipe Line Corp., and **Donald Russell,** Spartanburg, S. C., attorney, have been elected directors of Transcontinental.

J. P. Miller, superintendent of Service Pipe Line Co.'s Levelland, Tex., district, has been named Beaumont, Tex., district superintendent. He succeeds **J. A. Grant,** who has retired after 39 years with the company and its affiliates. **Lee May,** Longview, Tex., district superintendent, has been named superintendent of the Hays, Kans., district, succeeding **Joseph Thomasson.** Thomasson, who joined the company in 1921, has also retired. **C. L. Wilson,** Mineral Wells, Tex., district superintendent, has succeeded May in Longview.

P. S. McClure, marine exploration group manager in Shell Oil Co.'s New Orleans area, has been named area geologist. He succeeds **G. H. Samuels,** who has replaced **R. C. Knecht** as Southeast Louisiana exploration division manager. Knecht has succeeded McClure as marine exploration manager.

John D. Rogers, general manager of Humble Oil & Refining Co.'s marine division, and **J. E. Stoveken** and **Sydney Wire,** assistant general managers, will move to Houston in a few weeks to set up tanker-fleet headquarters there. The 24-tanker fleet, largest privately-owned fleet flying the American flag, has been headquartered in New York.

Richard A. Morse, Gulf Research & Development Co., Pittsburgh, has been named president-elect of AIME's Society of Petroleum Engineers for 1962. He also is a new director of AIME. New directors of SPE include **R. G. Parker,** Continental Oil Co.; **Sidney R. Richards,** Pan American Petroleum Corp.; **H. M. Stanier,** Sunray Mid-Continent Oil Co.; and **Roy H. Smith,** Pan American International Oil Co.

Officers of Big Chief Drilling Co., Oklahoma City, have taken over management of Seneca Oil Co., Oklahoma City independent. **William T. Payne,** chairman of Big Chief, and **Jack H. Abernathy,** president, will hold the same positions with Seneca. **Ted C. Findeiss,** attorney and secretary for Big Chief, has been elected vice president, and **F. E. Godfrey,** treasurer of Big Chief, will hold this post with Seneca. Payne, Abernathy, and Godfrey have been named directors of Seneca. **J. Fred McCown** has resigned as Seneca president but will continue as an independent operator in Oklahoma City.

E. N. (Sam) Self has been named vice president and field production superintendent in Newcastle, Wyo., for Coronado Oil Co., Denver.

E. H. Barsachs, engineer with Sunray Mid-Continent Oil Co., has been promoted to senior engineer in Abilene, Tex.

Edward A. Herring, engineering trainee in Continental Oil Co.'s southwestern region, has been promoted to production engineer in Denver City, Tex.

Dr. O. D. Weaver, Jr., consultant, has formed Weaver Oil & Gas Corp. with headquarters offices in Fort Worth. **Joe B. Jamar,** vice president of the new company, is geologist in charge of the eastern district office in Canandaigua, N. Y. **A. J. Weaver** is secretary-treasurer.

O. L. Furse, eastern area production manager for Humble Oil & Refining Co.'s former Humble division, has been assigned to the new Southeast region, New Orleans, as regional production manager. **E. A. Murchison, Jr.,** eastern area exploration manager, Humble division, has been named Southeast regional exploration manager. **E. M. Jolly,** manager of the Esso Standard division's Tennessee-Arkansas area, has been appointed Southeast regional marketing manager.

Deaths

W. Earle Witt, 62, president of Witt Oil Co., Evansville, Ind., died March 2 near Claremore, Okla. He suffered a heart attack while en route to Tulsa to visit relatives. Witt had been an independent operator in the Illinois, Indiana, and Kentucky areas for many years.

James A. Kennedy, 55, field engineer in Denver for National Supply Division of Armco Steel, died March 3 in Denver. He had been with National Supply and affiliated companies since 1924.

Rodney S. Durkee, 71, retired chairman of Lane-Wells Co., died March 5 in Los Angeles after a brief illness. Durkee had been with the old General Petroleum Corp.,

▶▶▶ Personals

George M. Parker, president and a director of Esso Export Corp., has been named senior representative for Standard Oil (N. J.) in London and Jersey stockholder representative for affiliates in the United Kingdom, Norway, Sweden, Denmark, and Finland. He succeeds **Paul J. Anderson,** who has been nominated for election to the Jersey board. The appointment is effective May 25.

PARKER

John D. Alexander has been promoted to research engineer, production research, in Continental Oil Co.'s research and development department.

Dr. J. F. Mathis has been named manager of Humble Oil & Refining Co.'s manufacturing research and development division at Baytown, Tex.

Wallace J. Awgun, construction superintendent for Refineria de Petroleos de Escombreras, SA, (Repesa) in Escombreras, Spain, has been transferred to New York as construction engineer with California Texas Oil Corp. Repesa is a Caltex affiliate.

K. M. Al Naqib has been transferred from Iraq Petroleum Co. in Kirkuk, Iraq, to Basrah Petroleum Co. in Basrah, Iraq, as senior geologist.

C. H. Marlar, Jr., junior process engineer for DX Sunray Oil Co. in Tulsa, has been promoted to process engineer.

Charles E. Myers, drilling engineer with Atlantic Refining Co., has been transferred to Corpus Christi. Tex., from Lafayette, La.

Daniel Y. Kim has been named division consulting geophysicist for Pan American Petroleum Corp.'s central division. He will headquarter in Oklahoma City.

Nelson Williamson, division exploitation geologist in Denver for British-American Oil Producing Co., has been transferred to Lafayette, La., in the same capacity.

Harry Dupre has been named assistant chief engineer, petroleum, for California Co. division of California Oil Co. He had been area superintendent for Bay Marchand field in Leeville, La. Dupre succeeds **William J. Hunter,** now chief engineer, production department, for California Oil's western division, Denver. Dupre will headquarter in New Orleans.

GREGATH

James R. Gregath, chief engineer in charge of An-Son Drilling Co.'s operations in Colombia and Ecuador, has been appointed vice president and manager of the company with headquarters in Oklahoma City. He succeeds **Marshall R. Joy,** who is on leave of absence.

Irving Senzel has been named lands staff officer in the Department of Interior's Bureau of Land Management. He succeeds **Harold R. Hockmuth,** recently promoted to associate director of the bureau.

William Wallace Mein, Jr., chairman of Bishop Oil Co. and Canadian-Bishop Oil, Ltd., has resigned both posts to devote more time to Calaveras Cement Co. **Louis J. Brunel,** who recently retired as Bishop's president, and **S. Waldo Coleman** have also resigned from the board. **George E. Lindelof, Jr.,** Los Angeles, has been elected a director of Bishop, and **Lewis Coleman,** San Francisco, has been elected a director of Canadian-Bishop.

Standard Oil Co. of New York, and Socony-Vacuum before joining Lane-Wells. He was elected president of Lane-Wells in 1939 and retired as chairman 2 years ago.

Floyd E. Palmer, 56, sales representative for Baroid division of National Lead Co., died March 3 in a Denver hospital. Palmer had been with Baroid for 27 years and had been Denver representative since 1950.

Thomas J. Weaver, 57, Denver consulting geologist, died February 21 in a Denver hospital after a short illness.

James David Campbell, 29, Clarksburg, W. Va., independent operator, died March 2 in an oil field accident near Rosedale, W. Va. Campbell had moved his operations to Clarksburg from Nowata, Okla., a few months ago.

Edwin Berry Cox, 77, Dallas independent producer, died March 6 in a Dallas hospital. Cox was an independent operator in Ardmore, Okla., before moving to Dallas in 1937.

Frederick T. Kafka, 41, area manager of Spanish Gulf Oil Co., Las Palmas, Canary Islands, drowned February 26 while on a fishing trip. Kafka had been with Gulf since 1947.

Osborne Bezanson, former president and chairman of Chemstrand Corp., died February 27 in a Boston hospital. Bezanson was vice president, a director, and member of the executive committee of Monsanto Chemical Co. before becoming president of Chemstrand in 1951. He served as chairman from 1953 to 1955.

Gabriel J. Lee, Jr., 49, Boulder, Colo., independent operator, was killed March 4 in an auto accident near Houston, where he was visiting relatives.

S. A. Leknes, 77, retired chief marine engineer for Gulf Refining Co., died February 18 in a Philadelphia hospital.

C. C. Boyd, West Salem, Ill., independent operator, died February 25 at his home.

J. O. Macy, 43, Mount Carmel, Ill., consulting geologist, died February 22 in a Marion, Ill., hospital after a long illness.

Value of gas liquids once topped that of natural gas

BY JOHN C. CASPER

GAS LIQUIDS, produced over the past 21 years, brought operators more than two-thirds as much income as all natural gas marketed in the same period.

Income from sales of natural-gas liquids amounted to 9.1 billion dollars in the 1940-60 period. Gas sales for the same period totaled 13.2 billion dollars.

Value of natural gas at the well ranged from 120.5 million dollars in 1940 to 1.73 billion dollars in 1960. Gas liquids carried a value of 68.3 million dollars back in 1940. The total was up to 812.3 million by 1960. Estimates are by the Bureau of Mines.

A comparison of total gas value and total gas-liquids value is shown by the middle line on the chart. Total value of all gas liquids at plants is expressed as per cent of total value of marketed dry gas at the well. Note four points on the value curve that are above the 100% line. These points are located by circles on the black line. For these years, the value of gas liquids exceeded value of natural gas at the well.

Since total value is the product of volume and unit price, lines were included to show these variables. The bottom line pictures gas-liquids energy as per cent of gas energy, based on production of both fuels each year. On an energy basis, gas liquids was equal to 8.9% of natural gas in 1940 and climbed to 12.96% in 1955. Limited variations tend to prove that volume was not the important factor that produced big changes in the value ratio.

Since there was a decided change in total-value curve and very little in the energy curve, value changes had to be produced by changes in unit price. The variations show up in the top curve.

Back in 1940, the price tag on a million B.t.u.'s of natural-gas liquids was 28.1 cents. The same amount of energy in natural gas brought 4.3 cents. Gas liquids sold for 6.5 times the price of gas or 650% of gas price.

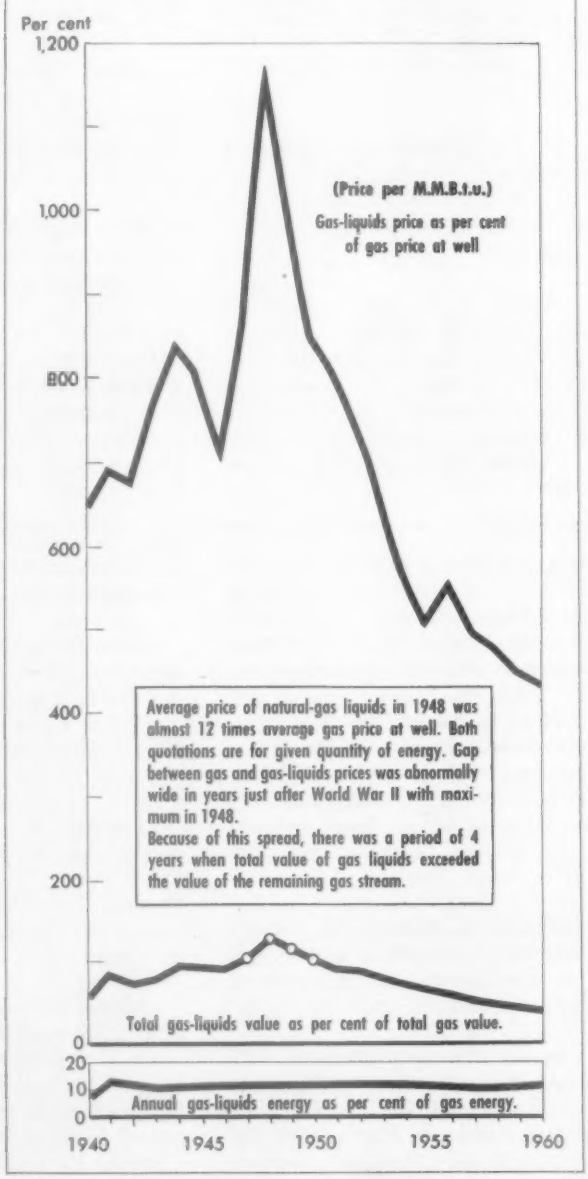
Rapid increases in demand for LPG and natural gasoline in the oil-shortage period after World War II placed a premium on gas liquids. The peak price was in 1948.

Average gas prices began to climb soon after 1948 at a time when gas-liquids prices eased off. It is estimated that gas-liquids energy in 1960 was selling for only 4.34 times gas energy.

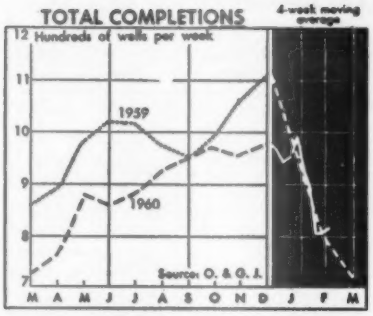
A quick look at the highlights . . .

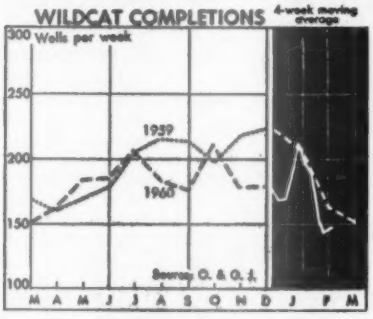
	LATEST WEEK	Change from WEEK AGO		Change from YEAR AGO	
Production	7,251,450	UP	66,675	UP	68,859
Crude stocks	231,452,000	UP	898,000	DOWN	21,697,000
Completions	777	DOWN	62	UP	15
Refinery runs	8,474,000	UP	98,000	UP	552,000
Gasoline stocks	221,092,000	DOWN	6,000	UP	1,664,000
Kerosine stocks	24,572,000	UP	767,000	UP	2,316,000
Distillate stocks	96,591,000	DOWN	125,000	DOWN	5,111,000
Residual stocks	42,886,000	DOWN	261,000	DOWN	1,323,000
Four-product stocks	385,141,000	UP	375,000	DOWN	2,454,000
Total imports	1,958,500	UP	323,000	UP	65,300

Gas vs. Gas Liquids


Per cent
1,200
1,000
800
600
400
200
0
(Price per M.M.B.t.u.)
Gas-liquids price as per cent of gas price at well
Average price of natural-gas liquids in 1948 was almost 12 times average gas price at well. Both quotations are for given quantity of energy. Gap between gas and gas-liquids prices was abnormally wide in years just after World War II with maximum in 1948.
Because of this spread, there was a period of 4 years when total value of gas liquids exceeded the value of the remaining gas stream.
Total gas-liquids value as per cent of total gas value.
20
10
0
Annual gas-liquids energy as per cent of gas energy.
1940
1945
1950
1955
1960

Active Rotary Rigs





	3-6-61	2-27-61	3-7-60
Alabama	5	4	4
Alaska	7	7	(*)
Arkansas	12	12	15
Arizona	0	1	1
California	72	66	84
Land	68	63	79
Offshore	4	3	5
Colorado	22	25	18
Florida	1	2	1
Land	0	1	0
Offshore	1	1	1
Georgia	1	1	0
Illinois	17	15	15
Indiana	3	4	4
Kansas	106	108	99
Kentucky	0	1	5
Louisiana	267	269	294
North	22	23	22
S. Inland waters	106	110	138
S. Land	83	80	87
Offshore	56	56	47
Michigan	19	21	39
Mississippi	47	50	63
Missouri	0	1	0
Montana	17	17	12
Nebraska	26	20	22
Nevada	1	1	0
New Mexico	84	87	98
North Dakota	16	14	11
Ohio	6	6	3
Oklahoma	175	168	180
Pennsylvania	3	5	6
Texas	569	537	598
S. Inland waters	9	7	8
S. Land	149	136	164
Offshore	3	2	0
North	54	47	40
Panhandle	47	52	50
East	50	43	41
West Central	†146	†135	198
West	111	115	97
Utah	28	27	25
Washington	1	1	0
West Virginia	4	5	4
Wyoming	51	54	55
Total U. S.	**1,560**	1,529	1,656
Cum. avg. to date	1,541	1,539	1,677
Western Canada	182	187	241
Eastern Canada	0	1	3
Grand total	1,742	1,717	1,900

Hughes Tool Co. report. *Data first reported. 4-4-60. †Stephens and Eastland counties now included in West Central.

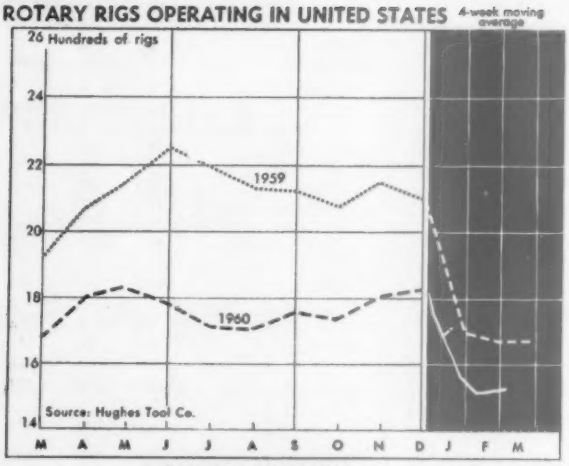
WEEKLY WELL COMPLETIONS . . . WEEK ENDED MARCH 4, 1961

	Total wells							Cum.		Total wildcats					Cum.	
	Total	Crude	Cond.	Gas	Dry	Service	Footage	1961	1960	Total	Crude	Cond.	Gas	Dry	1961	1960
Arkansas	17	6	0	0	11	0	55,688	99	115	3	0	0	0	3	24	31
California	36	24	0	4	7	1	200,075	315	236	5	0	0	0	5	43	56
Colorado	12	2	0	4	6	0	63,929	115	127	5	0	0	2	3	65	64
Illinois	20	10	0	0	9	1	55,833	355	460	8	2	0	0	6	75	120
Indiana	10	4	0	1	5	0	9,253	126	182	2	0	0	1	1	26	72
Kansas	94	50	0	4	26	14	214,777	949	631	20	2	0	0	18	183	189
Kentucky	16	5	0	2	8	1	21,441	197	394	2	1	0	0	1	20	46
Louisiana	39	15	0	1	23	0	322,936	594	595	6	0	0	0	6	80	86
North	12	5	0	0	7	0	43,390	222	194	1	0	0	0	1	30	37
South	24	8	0	1	15	0	252,810	294	303	4	0	0	0	4	46	44
Offshore	3	2	0	0	1	0	26,736	78	98	1	0	0	0	1	4	5
Michigan	13	5	0	0	8	0	43,482	139	134	5	0	0	0	5	60	46
Mississippi	11	6	0	0	5	0	115,135	110	143	2	0	0	0	2	39	54
Montana	7	3	0	0	4	0	45,536	72	49	5	1	0	0	4	36	26
Nebraska	26	14	0	0	12	0	124,984	132	135	10	1	0	0	9	60	57
New Mexico	27	14	0	5	8	0	142,014	296	357	5	0	0	0	5	49	54
West	9	4	0	4	1	0	48,464	121	119	0	0	0	0	0	14	11
East	18	10	0	1	7	0	93,550	175	238	5	0	0	0	5	35	43
New York	28	15	0	0	2	11	37,100	147	72	0	0	0	0	0	2	5
North Dakota	5	1	0	0	4	0	30,945	39	56	2	0	0	0	2	8	10
Ohio	10	4	0	2	3	1	20,819	181	227	1	0	0	1	0	8	12
Oklahoma	110	46	0	9	39	16	327,714	1,017	686	14	1	0	0	13	122	136
Pennsylvania	0	0	0	0	0	0	0	102	67	0	0	0	0	0	7	5
Texas	237	103	14	13	101	6	1,052,959	2,506	2,948	65	3	3	2	57	537	605
Dist. 1	13	4	0	0	8	1	39,743	144	216	7	0	0	0	7	54	80
Dist. 2	8	3	1	2	2	0	68,690	123	120	2	0	0	1	1	28	30
Dist. 3	15	2	4	1	8	0	131,484	187	239	7	0	2	1	4	53	48
Dist. 4	28	12	3	1	12	0	144,373	237	235	7	0	0	0	7	56	68
East	24	16	1	0	7	0	132,498	199	228	5	0	0	0	5	45	47
Dist. 7-B	31	15	0	1	15	0	88,085	347	412	9	2	0	0	7	94	118
West	55	25	2	1	27	0	232,846	616	780	23	1	0	0	22	136	124
Dist. 9	45	19	1	1	19	5	127,433	424	342	4	0	0	0	4	53	77
Dist. 10	18	7	2	6	3	0	87,807	229	186	1	0	1	0	0	18	13
Utah	8	4	0	2	2	0	53,464	42	49	3	0	0	1	2	23	19
West Virginia	18	2	0	15	1	0	45,601	186	160	0	0	0	0	0	0	1
Wyoming	26	6	0	0	20	0	138,283	192	182	14	0	0	0	14	84	74
Miscellaneous*	7	1	0	0	6	0	54,978	68	29	6	0	0	0	6	52	15
Total U. S.	777	340	14	62	310	51	3,176,946	7,979	8,034	**183**	11	3	7	162	1,603	1,783
Total prev. week	839	384	7	86	278	84	3,035,716	.....	.....	130	16	1	5	108	.....	.....
Cum. 1961	7,979	3,612	195	753	2,904	515	32,253,532	.....	.....	1,603	132	23	66	1,382	.....	.....
Cum. 1960	8,034	3,713	257	726	3,074	264	34,708,381	.....	.....	1,783	166	18	55	1,544	.....	.....
Western Canada	30	11	0	4	15	0	141,212	409	411	7	0	0	1	6	122	118

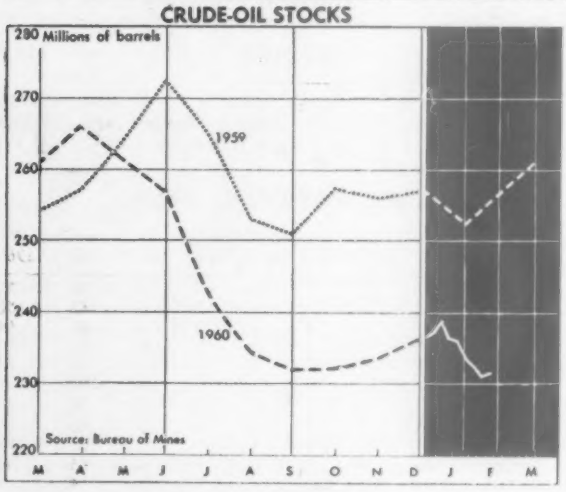
*Alaska, Fla., Mo., Ore.

PRODUCTION

ROTARY RIGS OPERATING IN UNITED STATES



CRUDE-OIL STOCKS



CRUDE-OIL STOCKS BY STATES OF ORIGIN *

(Thousands of barrels)

	2-25-61	2-18-61	2-27-60
Pennsylvania	2,154	2,113	2,268
Other Appalachian	1,312	1,211	1,947
Illinois, Indiana, Michigan	9,157	8,511	9,340
Nebraska and North Dakota	2,971	2,969	2,570
Kansas	8,951	9,256	9,291
Oklahoma	15,251	15,689	17,471
Arkansas	1,661	1,557	1,988
Louisiana	17,984	17,701	19,341
North	3,315	3,228	3,179
South	14,669	14,473	16,162
Mississippi, Alabama, Florida	2,117	1,806	2,924
New Mexico	7,322	7,067	7,442
Texas	96,874	97,411	108,357
East Texas	8,398	8,147	7,990
West Texas	44,325	44,775	50,422
Texas Gulf	16,353	16,404	18,592
Other Texas	27,798	28,085	31,352
Wyoming	16,875	16,756	17,228
Other Rocky Mountain	9,452	10,054	9,437
California	24,619	24,953	28,856
Foreign	†14,752	13,500	14,689
Total	**231,452**	230,554	253,149

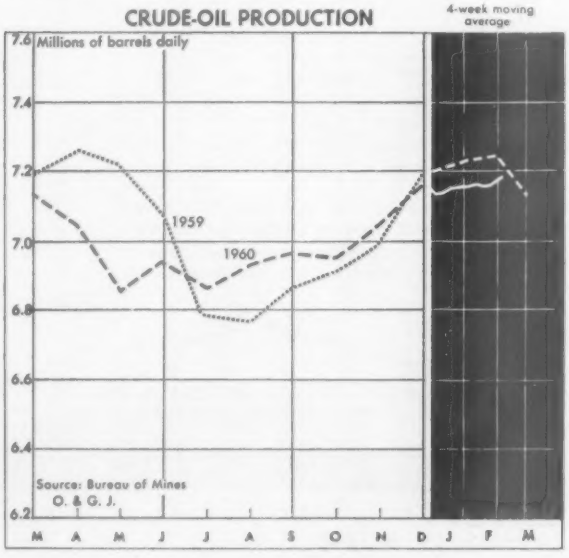
*Bureau of Mines. †Includes 4,791,000 bbl. in California.

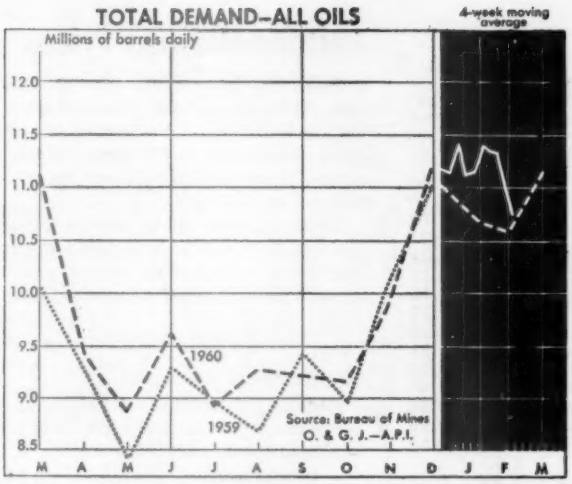
DAILY AVERAGE PRODUCTION FOR WEEK

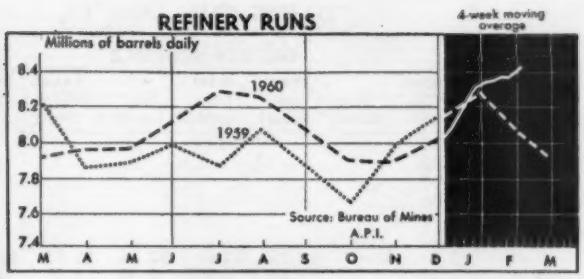
	March 4, 1961			Feb. 25
	Crude oil	Lease condensate	Total	total
Alabama	21,075	.....	21,075	21,050
Alaska	8,800	.....	8,800	8,200
Arkansas	78,150	175	78,325	78,325
California	823,800	.....	823,800	824,000
Colorado	132,100	.....	132,100	131,600
Eastern	39,500	.....	39,500	38,400
Florida	1,000	.....	1,000	1,000
Illinois	212,700	.....	212,700	213,500
Indiana	31,700	.....	31,700	32,200
Kansas	†313,850	.....	†313,850	†314,515
Kentucky	56,400	.....	56,400	56,300
Louisiana	995,250	156,150	1,151,400	1,138,100
North	105,550	6,150	111,700	111,850
South	889,700	150,000	1,039,700	1,026,250
Michigan	50,200	.....	50,200	49,500
Mississippi	146,450	4,525	150,975	150,950
Montana	82,000	.....	82,000	81,700
Nebraska	66,900	.....	66,900	66,400
Nevada	300	.....	300	50
New Mexico	294,725	8,500	303,225	300,000
North Dakota	71,200	.....	71,200	71,000
Oklahoma	†509,000	.....	†509,000	†529,750
Texas	2,567,700	100,150	2,667,850	2,600,350
Dist. 1	42,850	3,700	46,550	45,700
Dist. 2	109,575	8,800	118,375	112,400
Dist. 3	320,850	42,000	362,850	358,000
Dist. 4	183,425	14,000	197,425	192,000
Dist. 5	27,850	500	28,350	27,500
Dist. 6	117,300	9,000	126,300	121,500
East Texas Field	136,300	.....	136,300	132,000
Dist. 7-B	130,575	500	131,075	128,400
Dist. 7-C	117,275	3,850	121,125	117,050
Dist. 8	1,088,275	12,000	1,100,275	1,070,000
Dist. 9	190,275	3,800	194,075	192,800
Dist. 10	103,150	2,000	105,150	103,000
Utah	93,500	.....	93,500	97,000
Wyoming	385,100	.....	385,100	384,000
Others	‡550	.....	‡550	‡700
Total U. S.	6,981,950	269,500	**7,251,450**	1,188,590
Change from prev. week, up			**62,860**	.....
Canada	†602,200	.....	†602,200	†612,700
Total U. S. production—Jan. 1-Mar. 4				451,880,200 bbl.
Same period last year (crude plus cond.)				*455,531,800 bbl.

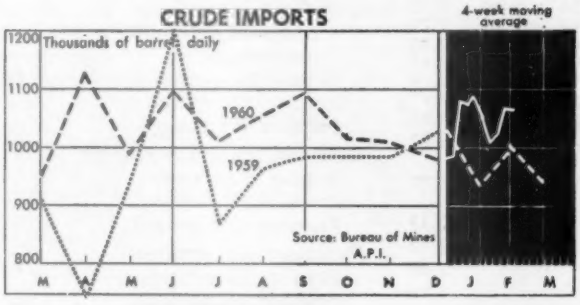
*Includes 14,293,200 bbl. condensate. †Week ended previous Monday. ‡South Dakota and Arizona.

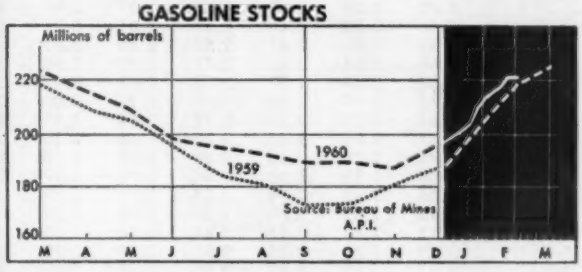
CRUDE-OIL PRODUCTION

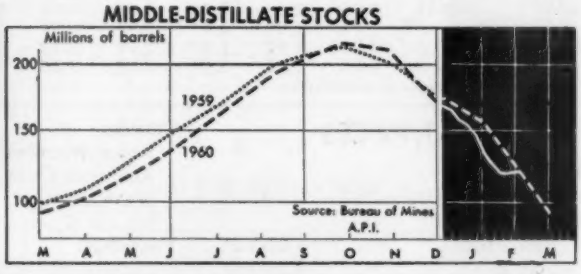


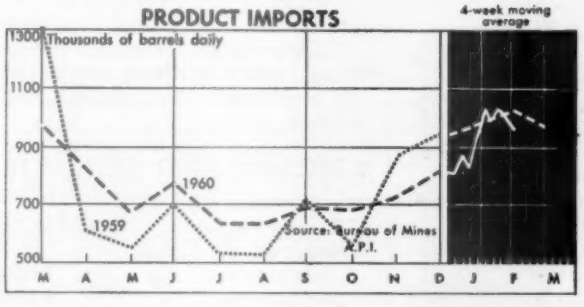


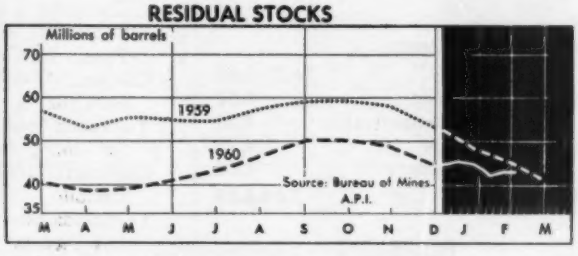












API REFINERY REPORT—MARCH 3, 1961

(Thousands of barrels)

District—	Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.	Stocks‡ Gaso.†	Kero.	Dist.	Resid.	Bureau of Mines, March 1960 Daily avg. runs	Daily average production Gaso.*	Kero.	Dist.	Resid.
East Coast	1,210	509.6	61.1	364.1	175.0	46,443	9,903	31,146	12,427	1,111	525.4	34.1	343.9	170.7
Appalachian:														
Dist. 1	99	46.7	4.4	25.4	14.9	5,841	700	2,554	557	100	39.1	4.4	21.4	12.7
Dist. 2	92	49.6	6.7	18.6	13.4	3,269	343	1,007	358	102	43.6	8.8	15.8	17.1
Ind., Ill., Ky.	1,537	763.8	74.1	352.1	165.3	38,936	4,363	16,534	5,328	1,468	734.5	77.3	316.9	210.0
Minn., Wis., Dak.	124	57.3	6.1	25.3	16.7	7,033	617	4,762	602	116	55.5	5.8	26.5	19.8
Okla., Kans., Mo.	743	378.6	16.0	186.6	18.6	21,238	1,036	8,919	827	685	380.2	13.0	170.9	43.5
Inland Texas	291	221.7	7.6	52.1	17.9	8,476	427	1,275	2,479	286	211.6	8.9	51.8	19.2
Texas Gulf Coast	2,077	958.8	166.8	556.2	171.1	33,966	2,706	8,630	5,342	1,864	940.9	124.1	418.3	136.5
La. Gulf Coast	706	325.4	76.5	204.7	48.8	12,382	1,595	3,506	1,247	645	358.7	52.1	142.3	44.2
N. La. and Ark.	116	69.3	4.3	24.6	7.9	5,982	825	2,198	135	100	65.8	4.0	21.8	7.1
Rocky Mountain:														
New Mexico	25	12.0	0.7	6.1	2.4	838	46	182	76	25	12.5	0.5	4.1	2.8
Other Rocky Mt.	263	126.3	5.6	69.3	31.7	7,669	409	2,287	1,031	280	130.1	3.4	64.4	33.7
West Coast	1,191	519.9	34.4	189.6	297.9	29,019	1,603	13,591	12,485	1,135	539.6	29.9	198.4	284.8
Mar. 3, 1961	8,474	4,049.0	464.3	2,074.7	981.6	221,092	24,572	96,591	42,886	7,917	4,037.5	366.3	1,796.5	1,002.1
Feb. 24, 1961	8,376	4,113.4	394.9	2,246.4	990.4	221,098	23,805	96,716	43,147	.....	.....	.....	.....	.....
Mar. 4, 1960	7,922	4,062.0	338.7	1,735.6	1,068.1	219,428	22,256	101,702	44,209	.....	.....	.....	.....	.....

*At refineries including natural blended. †Finished and unfinished. ‡At refineries, bulk terminals, in transit, and in pipelines.

CRUDE-OIL PRICES

GRAVITY SCHEDULE

	Signal Hill, Calif.	Oklahoma	West Tex. (sour)	West Tex. (Inter.)	No.* Texas	Texas Refugio Light	Bayou Sale (La.)	Denver Jules-burg	Wyo. (sour)
14-14.9	$1.86	....	....	....	....	....	....	....	....
15-15.9	1.93	....	....	....	....	....	....	....	1.81
16-16.9	2.00	....	....	....	....	....	....	....	1.86
17-17.9	2.06	....	....	....	....	....	....	....	1.96
18-18.9	2.13	....	....	....	....	....	....	....	1.96
19-19.9	2.20	....	....	....	....	....	....	....	2.01
20-20.9	2.27	$2.49	$2.35	$2.61	$2.29	$2.95	$2.90	$2.58	2.06
21-21.9	2.33	2.52	2.38	2.63	2.33	2.97	2.92	2.60	2.11
22-22.9	2.40	2.55	2.41	2.65	2.37	2.99	2.94	2.62	2.16
23-23.9	2.46	2.58	2.44	2.67	2.41	3.01	2.96	2.64	2.21
24-24.9	2.53	2.61	2.47	2.69	2.45	3.03	2.98	2.66	2.26
25-25.9	2.60	2.64	2.50	2.71	2.49	3.05	3.00	2.68	2.31
26-26.9	2.67	2.67	2.53	2.73	2.53	3.07	3.02	2.70	2.36
27-27.9	2.74	2.70	2.56	2.75	2.57	3.09	3.04	2.72	2.49
28-28.9	2.81	2.73	2.59	2.77	2.61	3.11	3.06	2.74	2.54
29-29.9	2.87	2.76	2.62	2.79	2.65	3.13	3.08	2.76	2.59
30-30.9	2.93	2.79	2.65	2.81	2.69	3.15	3.10	2.78	2.63
31-31.9	3.00	2.82	2.68	2.83	2.73	3.17	3.12	2.80	2.67
32-32.9	3.06	2.85	2.71	2.85	2.77	3.19	3.14	2.82	2.71
33-33.9	3.12	2.88	2.74	2.87	2.81	3.21	3.16	2.84	2.75
34-34.9	3.17	2.91	2.77	2.89	2.85	3.23	3.18	2.86	2.79
35-35.9	3.22	2.94	2.80	2.91	2.89	3.25	3.20	2.88	2.83
36-36.9	3.27	2.97	2.83	2.93	2.93	3.27	3.22	2.90	2.87
37-37.9	3.31	2.99	2.86	2.95	2.95	3.29	3.24	2.92	2.89
38-38.9	....	3.01	2.89	2.97	2.97	3.31	3.26	2.94	2.91
39-39.9	....	3.03	2.92	2.99	2.99	3.33	3.28	2.96	2.93
40-44.9	....	3.05	2.95	3.01	3.01	3.35	3.30	2.98	2.95

*Cooke, Grayson, Montague.

FLAT PRICES

Louisiana:	
Sweet Lake	$3.00
Texas:	
East Texas	3.05-3.25
Conroe	3.23-3.53
Van	3.08
Pennsylvania Grade:	
Bradford	$4.75-4.80
Middle District	4.52
Southwest Pennsylvania	4.25
West Virginia	4.17
Buckeye Grade	4.08
Illinois Basin	3.00-3.05

FOREIGN

Middle East, Persian Gulf: (cargoes f.o.b. lifting port)	
Arabian, 34.0°-34.9°, Ras Tanura	$1.80
Iranian, 34.0°-34.9°, Bandar Mashur	1.78
Iranian, 34.0°-34.9°, Abadan	1.73
Iraq, 35.0°-35.9°, Fao	1.72
Kuwait, 31.0°-31.9°, Mina-al-Ahmadi	1.59
Qatar, 41.0°-41.9°, Umm Said	1.95
Middle East, E. Mediterranean:	
Arabian, 34.0°-34.9°, Sidon	$2.17
Iraq, Mosul-Kirkuk, 35.0°-35.9°, Tripoli	2.19
Far East (cargoes, f.o.b. Lutong, Sarawak):	
Seria Light, 36°	2.42
Canada:	
Leduc-Woodbend	$2.53
Redwater (Alta.)	2.42
Weyburn (light)	2.06
Midale C	1.70
Venezuela:	
Cumbarebo, 47°-47.9°, Tucupido	3.34
San Joaquin, 40°-40.9°, Puerto La Cruz	3.08
Oficina, 35°-35.9°, Puerto La Cruz	2.80
Tia Juana medium, 26°-26.9°, Amuay*	2.30
Quiriquire, 16.0-16.4°, Caripito	2.10
Lagunillas heavy, flat, Las Piedras*	2.10
Bachaquero, flat, 15°-16°, Las Piedras*	1.88

Prices for all crudes of 24° or lighter vary 2 cents per degree change, up or down. All crudes heavier than 24° vary 2.5 cents per half-degree gravity change.

*Also available at La Salina at 3 cents per barrel less.

TANKER RATES (Long Ton)

(Latest reported spot fixtures)

★ Gulf-NY, clean (ATRS—0.0%)	$2.85
★ Gulf-NY, dirty (ATRS—0.0%)	2.85
Carib.-NY, dirty (ATRS—60%)	1.10
★ Carib.-UK, dirty (Scale—65%) (11s. 5d.)	1.60
PG-UK, dirty (Scale—50%) (30s. 2d.)	4.23

★Denotes change previous week.

Refined-Product Prices

Following quotations are realistic spot prices for refined products moving interstate on Wednesday each week. They may differ from refiners' posted prices and should not be considered as postings.

Light-product prices are in cents per gallon. Residual and crude prices are dollars per barrel. Crude prices are at the well unless otherwise listed.

GASOLINE*

Mid-Continent (Group 3):	
Regular (91 octane)	12.00-12.25
Premium (99 octane)	14.75-15.00
Natural gasoline (26-70)	4.5
Breckenridge	4.0
Gulf Coast (cargoes for coastwise or export movements):	
Regular (90 octane)	11.00
Regular (92 octane)	11.25
Premium (98 octane)	12.25
California (rack) Los Angeles:	
Regular (90 octane)	11.30
Premium (95 octane)	12.30
Premium (100 octane)	13.80
Caribbean area (cargoes):	
Regular (87 octane)	9.50
Premium (97 octane)	11.625

*Quotations are for octanes shown. Prices usually vary with octane ratings within the regular, premium, and aviation grades.

KEROSINE AND DISTILLATE

Mid-Continent (Group 3):	
Kerosine 42-44	10.625-10.75
Diesel oil (58 d.i. and above)	10.25
Distillate No. 1	10.25
Distillate No. 2	9.25
Gulf Coast (cargoes):	
Kerosine 41-43	10.25
Distillate No. 2	9.50
New York Harbor (barges):	
Kerosine 42-43	11.90
Distillate No. 2	10.90
Diesel fuel, 48-52 d.i.	11.05
Caribbean area (cargoes):	
Distillate No. 2	8.625

RESIDUAL FUEL (Bbl.)

Mid-Continent (Group 3):	
Residual fuel (max 1% S)	$1.90
Gulf Coast (cargoes):	
Bunker C fuel	2.30
New York Harbor (barges):	
Bunker C fuel	2.52
Caribbean (cargoes):	
California (rack):	
Bunker C fuel, Los Angeles	2.25
★ Bunker C	2.00

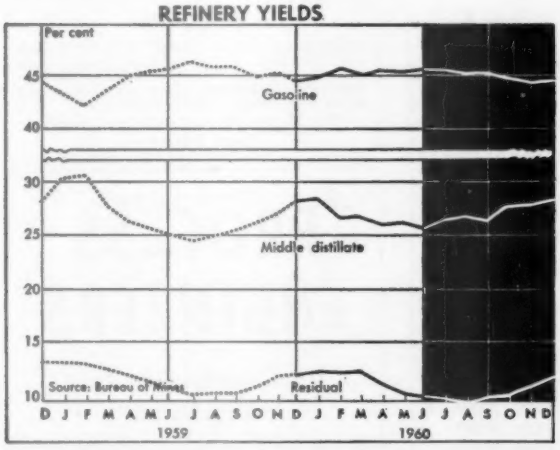
SUPPLY AND DEMAND—PRODUCTS

(Thousands of barrels daily)

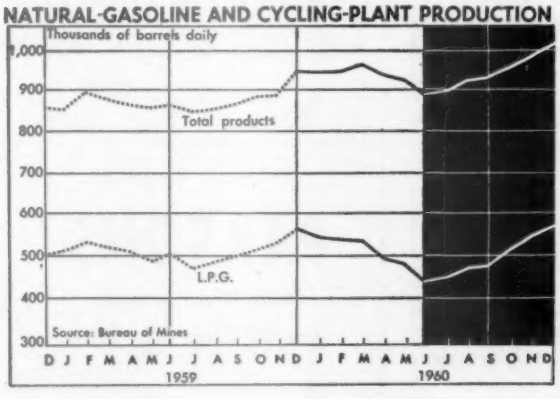
	Total demand	Refinery production	Stocks end of period†
GASOLINE			
February 1961*	3,900	4,080	221,100
January 1961*	3,740	4,160	213,500
December 1960	4,054	4,219	194,774
March 1960	3,928	4,092	222,691
February 1960	3,786	4,149	217,139
KEROSINE			
February 1961*	515	430	24,000
January 1961*	620	450	27,700
December 1960	607	431	31,445
March 1960	517	366	18,440
February 1960	483	359	23,020
DISTILLATE			
February 1961*	2,725	2,215	96,700
January 1961*	3,155	2,085	109,200
December 1960	3,103	1,910	138,455
March 1960	2,843	1,796	73,948
February 1960	2,553	1,789	105,015
RESIDUAL			
February 1961*	1,870	970	43,100
January 1961*	1,890	950	43,700
December 1960	1,889	996	44,870
March 1960	2,015	1,002	40,503
February 1960	1,982	998	45,775

*Preliminary. †Thousands of barrels.

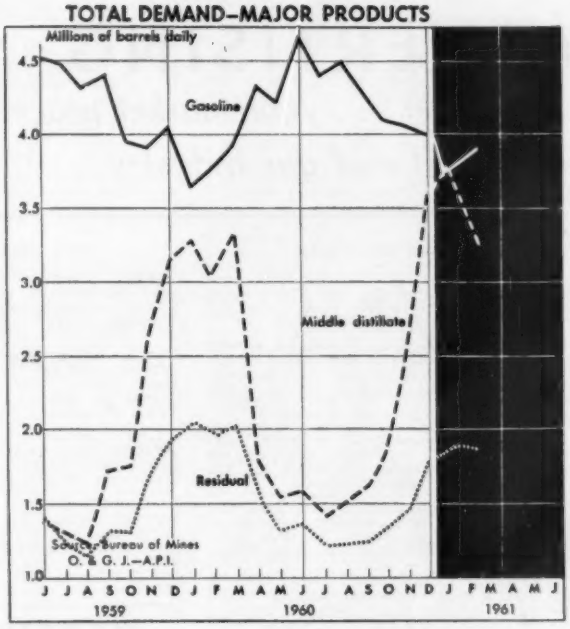
REFINERY YIELDS



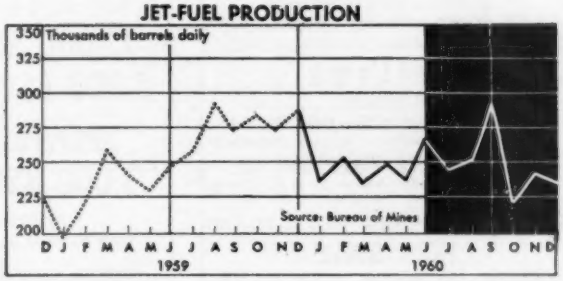
NATURAL-GASOLINE AND CYCLING-PLANT PRODUCTION



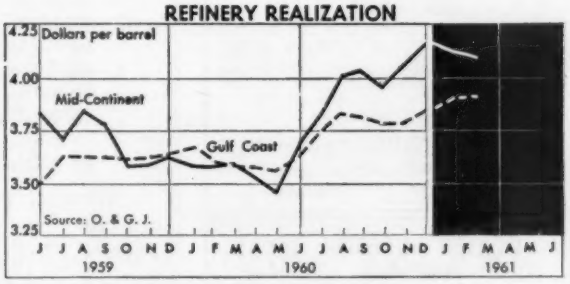
TOTAL DEMAND–MAJOR PRODUCTS



JET-FUEL PRODUCTION



REFINERY REALIZATION



REFINERY REALIZATION

	Feb.*	Jan.*	Dec.	Nov.
Mid-Continent	$4.09	$4.12	$4.12	$4.06
Gulf Coast	3.92	3.90	3.82	3.81

*Preliminary. Refinery realization is based on yields of major products and average spot prices of regular gasoline, kerosine, No. 2 fuel, and residual as published in The Oil and Gas Journal.

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9 MM BTU/hr.	Carbon	Tubes
7.5 MM BTU/hr.	CHROME	Tubes (2)
5 MM BTU/hr.	Carbon	Tubes
2.5 MM BTU/hr.	Carbon	Tubes
2 MM BTU/hr.	Carbon	Tubes

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Tulsa, Oklahoma

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FEDERAL LAND leases available for this year's working deals. Southeast Utah—Northeast Wyoming. Good terms arrangeable. Write: Box 591, Altadena, Calif.

200 ACRES—Archer County, Texas. 7 wells, 1,000 ft. Gunsite Sand, 1 injection well. More locations to drill. Waterflood started. Present settled production 30 BPD. Inquire: 7003 Westlake Drive, Dallas.

5,000 ACRE RECTANGLE N.E. Kentucky Within brown area, Page 54, May 30, 1960, The Oil and Gas Journal. Box 446, Charleston 22, W. Virginia.

WANT TO PURCHASE Gas and Oil Properties—Submit Reserve Estimates, Income, etc. Box M-210, The Oil and Gas Journal, Tulsa, Oklahoma.

OIL LEASE CRANE County, Texas: Available S/320 acres, Section 18, Block B-28, PSL, two miles from new gas discovery Section 23, Blk. 4, H&TC, Hill & Meeker well. Quick action, address landowner: Jefferson G. Smith, 715 Littlefield Building, Austin 15, Texas.

OHIO AND WEST VIRGINIA acreage for sale close to Big Play. Specialize in 10-15 thousand acre blocks or will lease on your form anywhere in the East. David Law, 716 Union Trust Bldg., Parkersburg, West Virginia. Phone: HU 5-6446.

Will sell a few "several thousand acre checkerboards" of leases in various areas in Pennsylvania and Ohio where seller will promptly test Oriskany, Helderberg, Medina and deeper formations—no pro-ration—ready market @ 27 cents per M.C.F. Seller willing to participate in drilling deals with responsible buyers. Excellent success record of seller includes recent significant Oriskany gas pool discovery in Ashtabula County, Ohio and "Shearer Oil Pool" discovery in Coshocton County, Ohio in 1952. Write to:

James I. Shearer, President, James Drilling Corporation
250 Newport Road, Blairsville, Pennsylvania

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Box M-316, The Oil and Gas Journal, Tulsa, Oklahoma

CAPITAL AND TIME to invest in aggressive company. Petroleum Engineer, 34, 10 years domestic and foreign service company experience including sales and management. Will purchase or invest in right opportunity. Box 31 Q 112, The Oil and Gas Journal, 4041 Marlton Ave., Los Angeles 8, Calif.

GROWING CORP. will trade marketable stock for minerals, production or working interest in proven lease. Box M-306, The Oil and Gas Journal, Tulsa, Oklahoma.

FINANCIAL—Investment Banking Houses and Underwriters reached. Confidential. You can send the details of your proposition direct or thru your attorney to Consultant 817—51st Street, Brooklyn, N. Y.

EXPERIENCED AND responsible Producer and Operator desires associates to join in drilling shallow ventures in North Texas area. Bank references exchanged. Box M-294, The Oil and Gas Journal, Tulsa, Oklahoma.

PRODUCING LEASE
IVANHOE DOME FIELD
Central Montana Tyler Production

SEALED BIDS will be received by the undersigned until 2:00 o'clock P.M., Friday, March 31, 1961, for purchase by cash of 100% of the working interest of five (5) Tyler sands wells (presently producing approximately 220 BOPD and miscellaneous personal property constituting and located upon the following:

All of Sec. 16, T-11N, R-31E, Musselshell and Rosebud Counties, Montana, containing 640 acres, more or less.

Additional information may be requested from or inspected at 803 Midland Bank Building, Billings, Montana.

The right to reject any or all bids is reserved.

Final decision with reference to the disposition of the bids will be made within fifteen (15) days of the opening.

Upon acceptance of any bid the applicant must tender a certified check in the amount of $10,000.00 within five (5) days of notification of acceptance. Balance upon title clearance.

J. V. Montalban,
Receiver for R. P. Oliver Ltd.
803 Midland Bank Building
Billings, Montana.

REAL ESTATE

MEXICAN RANCH—60,000 acres on main highway, 180 miles from Eagle Pass, Texas. Beautiful mountain valley, excellent grazing or dude ranch layout. $2.50 per acre. Box M-301, The Oil and Gas Journal, Tulsa, Oklahoma.

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WELL COMPLETION cards for Eastern Colorado, Western Nebraska, Wyoming, Montana, Utah, Northwestern Colorado, Western Kansas, North Dakota, South Dakota. Will sell all or part. F. H. Stevens, 2929 Monte Vista N. E., Albuquerque, New Mexico.

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WANT TO PURCHASE; oil production, stripper or better in Indiana, Illinois or Kentucky. E. D. Harmon, P. O. Box 634, Evansville 2, Indiana.

WANT TO BUY
Marginal production with water-flood potential.
Box M-300
The Oil and Gas Journal
Tulsa, Oklahoma

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D. C. Notice is hereby given that approximately 30 acres of land in one parcel within the known geologic structure of a producing oil and gas field, undefined, in Allegan County, Michigan, will be offered for competitive oil and gas leasing through sealed bids to the qualified bidder of the highest cash amount per acre at 1:00 P.M., E.S.T. March 29, 1961, when bids will be opened. Full details of the lease offering, and how and where to submit bids, may be obtained from the Manager, Eastern States Land Office, Bureau of Land Management, Washington 25, D.C. H.K. Scholl, Manager.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D. C. Notice is hereby given that approximately 321.89 acres of land in two parcels, 79.99 acres within the undefined known geologic structure of the Pine Island field and 241.90 acres within the known geologic structure of the Greenwood-Waskom field, in Caddo Parish, Louisiana, will offered for competitive oil and gas leasing through sealed bids to the qualified bidder of the highest cash amount per acre at 1:00 P.M., E.S.T. **April 5, 1961,** when bids will be opened. Full details of the lease offering, and how and where to submit bids, may be obtained from the Manager, Eastern States Land Office, Bureau of Land Management, Washington 25, D.C. H.K. Scholl, Manager.

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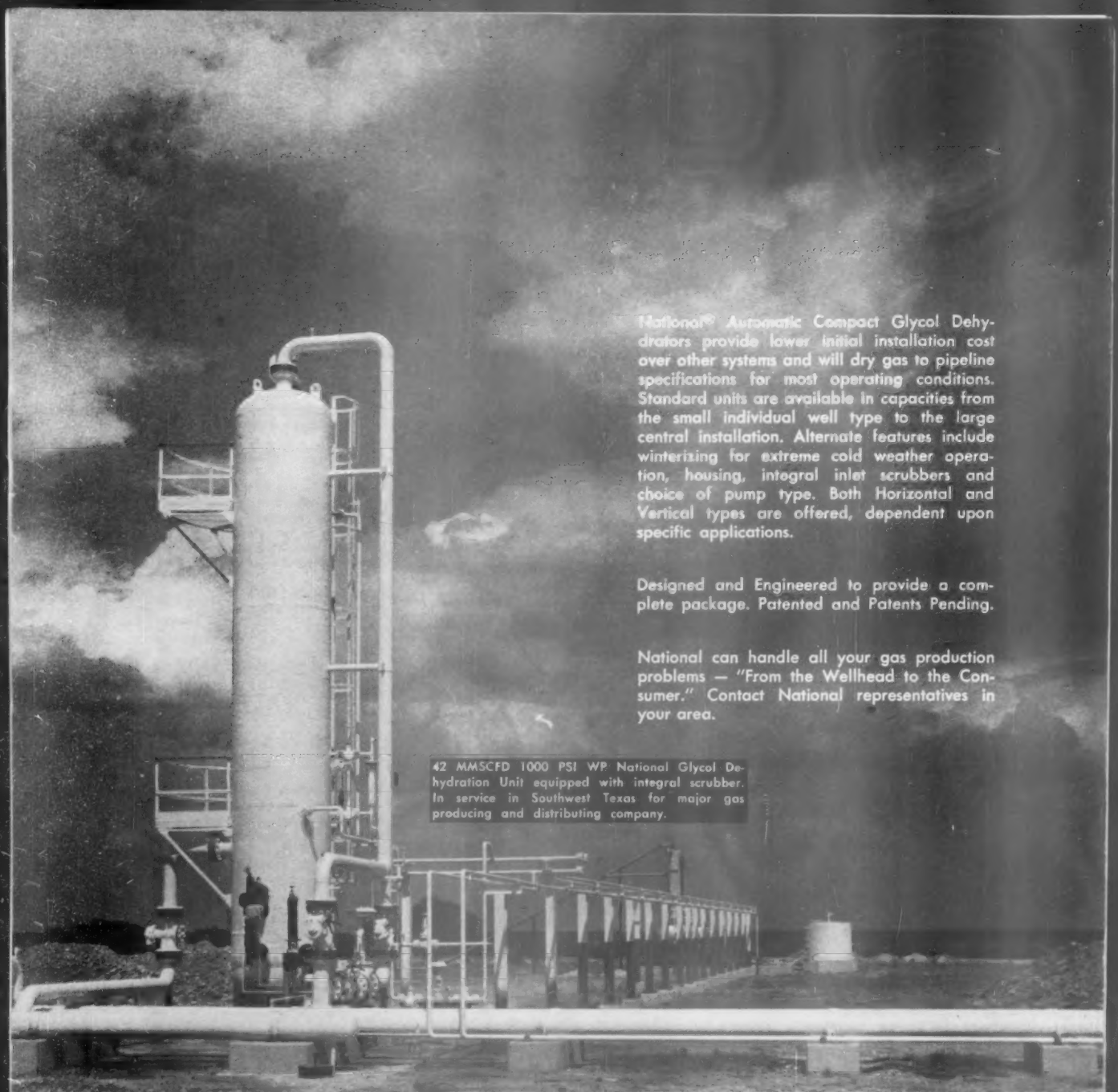

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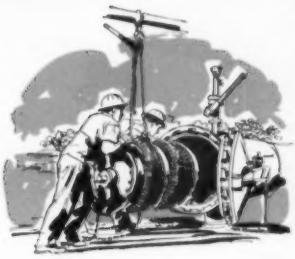

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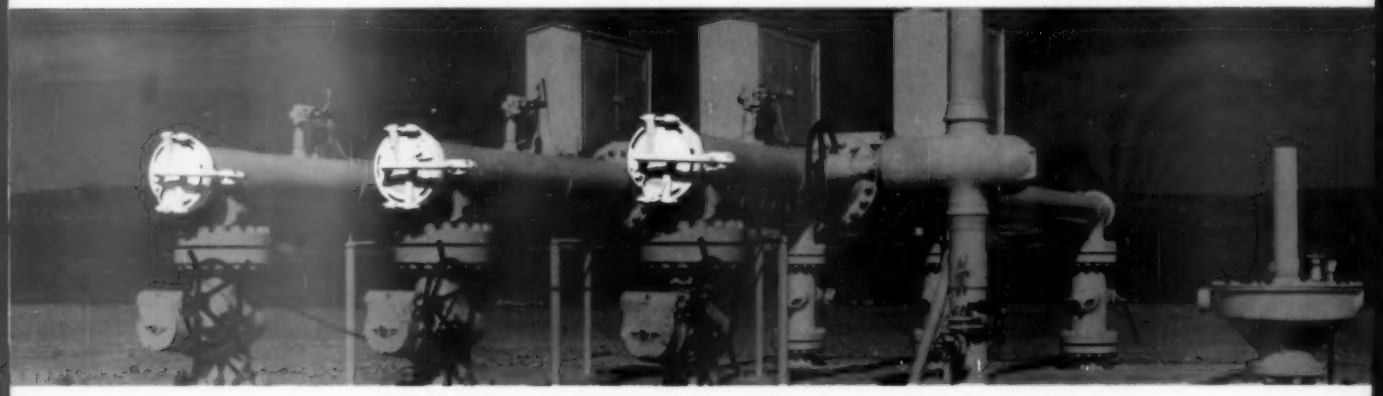

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(Left) Gas pipeline blowoff head equipped with UNIBOLT Closures on a cantilever hinge for easy opening. A bleeder plug is provided for safely relieving pressure that may leak thru the riser valve. (Right) UNIBOLT Welding Neck Couplings in a products pipeline manifold. The cross-overs are equipped with a half-coupling which interchanges with blanking plugs on the risers. This arrangement eliminates many valves and insures against commingling of products.

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